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Contents

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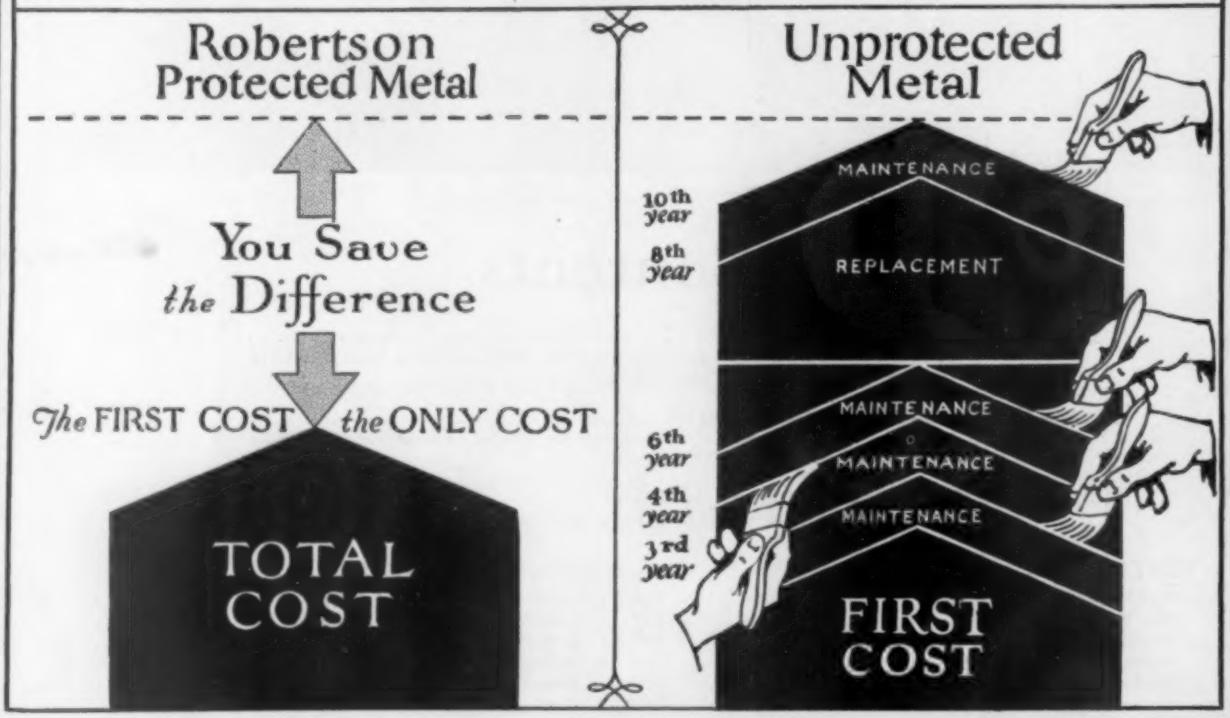
The COST of Your Roof
over a 10 YEAR period



When you buy a new roof for your building don't let the first cost govern entirely your choice of the roofing material. Instead, be guided by the TOTAL COST determined by the service the roof will give over a span of years. This is the real basis upon which to make comparisons of roofing materials.

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Railway Age

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Bookkeeping Yardmasters

THERE is a widespread theory that the yardmaster is not and should not be a bookkeeper. While it is true that yardmasters who spend too much time in their offices and too little in their yards are not efficient, neither are those yardmasters efficient who make no use whatever of reports, figures and other purely office work. The yardmaster who is doing most to make his yard a success is the yardmaster who knows most about his daily yard costs; how much fuel the yard engines are consuming, the number of cars being light-weighed, the number of engines being fired up and held under steam to protect his assignments, what it is costing him per car to handle his traffic, the amount of overtime being made, and the number of cars handled per hour or job. Unless he knows these things, he is lacking in definite knowledge of his operation, without which knowledge he cannot hope to render efficient supervision. If this sort of thing be classed as bookkeeping, then the yardmaster who is also a bookkeeper is a good yardmaster.

Men Who Pound the Keys

CHIEF dispatchers are highly important cogs in the transportation machine. They have almost endless opportunities to effect operating economies, including the handling of power so as to increase car movement, saving fuel by avoiding light mileage, avoiding delays in yards after crews are called, and by intelligent supervision to avoid unnecessary stops. Yet, on some railroads, the chief dispatcher is kept so busy on his job that it is not possible for him to do anything else, even to learn modern operating methods. To get full value from a chief dispatcher it is necessary that his viewpoint be broad. He must be able to visualize the system as a whole rather than to regard the division under his nose as a separate entity. Chief dispatchers should be given ample opportunities to get the views of others. They should be invited to attend conferences on operation whenever it is possible for them to do so, and, in general, everything possible should be done to prevent them from getting into a rut, with no interest save that of getting the trains over the division as well as last year, the year before, or the year before that.

Reducing Interlocking Costs

TWO important factors now permit more economical construction and operation of interlocking plants at outlying crossings, which should result in the installation of such facilities at points where, under the older practices which required additional equipment, the expense was not considered to be justified. The action of Committee X, of the Signal section, A. R. A., in 1924, in recommending the elimination of derails provided an incentive for the use of so-called signaling-interlockings, including automatic signal protection at railroad grade crossings without derails or the necessity for levermen. Several such plants have since been installed at points where house track or other little-used switches came within the limits of the home signals which were not operated by the interlocking but were protected in the same manner as any switch in automatic block territory. This principle of non-interlocked switches is also being used in plants attended by levermen at points where train operation requires operators. The elimination of derails, and the inclusion of non-interlocked switches in home signal limits open new fields which permit economies to be effected that justify the installation of interlocking plants at many crossings and junctions where such protection is adequate for the track layout and traffic involved.

Distribution of Perishables

A SIDE-LIGHT on transportation progress in so recent a period as the last ten years may be gained from reading a study made by the Bureau of Railway Economics of rail shipments of 16 principal fruits and vegetables. This shows that in the years 1917-1919 the annual average rail shipments of the 16 principal fruits and vegetables amounted to 478,540 carloads. For 1924, 1925 and 1926 production had increased to the point where the annual average rail movement was 848,099 carloads, an increase of 77 per cent compared with ten years ago. The total population of the country during the period increased only 12 per cent. Moreover, shipments are more widely and more thoroughly distributed now than ten years ago. The study indicates that the city of Chicago, for instance, in 1925 was served with white potatoes shipped by rail from 37 states, sweet potatoes from 16 states, cabbage from 22 states, onions from 20 states, lettuce from 13 states, tomatoes from 17 states, cantaloupes from 14 states, apples from 25 states, peaches from 19 states and strawberries from 15 states. This would not be possible, of course, without the special attention given and improvements in service made by the railroads in the handling of these products.

Development of Motor Transportation

THREE years ago the railways in the United States were just beginning to give serious thought to the economic possibilities of the operation of motor coaches in conjunction with rail operation. During this short period of time rapid progress has been made in the development and organization of motor transport. Many railways now have in operation fleets of motor coaches. During 1926 the Railroad Motor Transport Conference

was organized with the object of making intensive studies of the problems in connection with motor transport. The fact that F. J. Swentzel, mechanical superintendent, New England Transportation Company, read a paper on this subject at the Mechanical Division meeting in Montreal indicates that the American Railway Association has recognized the growing importance of this phase of transportation. Mr. Swentzel pointed out some of the problems which his company has been called on to solve, as well as some of the problems that yet remain to be followed through to a successful solution.

In the future the larger problems that will confront these motor coach operations will probably be more and more of a technical nature. The Mechanical Division is showing enterprise in taking up the subject without delay.

Personalities at the Mechanical Convention

UNDER the inspiring leadership of Chairman L. K. Sillcox, the committee work undertaken by the American Railway Association, Mechanical Division, during 1926, was unusually extensive and thorough, as evidenced by the 19 committee reports, abstracts of which, together with the discussion, appear in this issue. The most notable feature of the convention held at Montreal, Que., June 7 to 10, however, was undoubtedly the large number of distinguished men on the program who made addresses and presented individual papers. Quite a number of nationally known figures in the railroad world were present, including such men as the Right Honorable George P. Graham, P. C., R. H. Aishton, Frank McManamy, M. J. Gormley, Dean A. A. Potter, A. G. Pack, Prof. W. J. Cunningham and Dr. W. F. M. Goss. Of them all, the most distinguished, in point of view of scientific achievement, is Doctor Goss, at present a retired affiliated member of the Mechanical Division, but for many years a leading exponent of the application of scientific methods to the solution of railroad problems, particularly in the mechanical department. With such an array of talent, the members of the Mechanical Division can hardly have failed to take home with them from the convention, sufficient information and inspiration to serve as an effective aid in carrying on their work throughout the coming year.

Saving a Billion Dollars in a Year in Rates

REDUCTIONS in railway rates made since they were at their peak in 1921 will save the traveling and shipping public about one billion dollars in the year 1927, if freight business continues throughout the year to be relatively as large as it has been thus far and average rates continue to decline. This estimate of the saving that will be made in 1927 is based, first, on the fact that freight business thus far has been larger than last year; secondly, on the fact that the average rates received have been lower; and, third, upon the actual saving made under the operation of the same influences in 1926 and preceding years. The railways actually received $910,224,000 less for handling freight and passenger traffic in 1926 than they would have received if the peak rates of 1921 had been in effect. Of this total saving shippers received about $857,000,000 and passengers about $53,000,000. The savings in other years to the shipping and traveling public from reductions in rates made since 1921 have been as follows: 1922, $350,427,000; 1923, $682,046,000; 1924, $656,508,000; 1925, $788,895,000. Adding to these figures the savings for 1926 makes a total for five years of $3,391,000,000, and if the estimate above made for 1927 proves correct, the total for six years will be close to $4,400,000,000, or an average of over $700,000,000 annually. Only the great economies in operation that have been effected have rendered it possible for the railways to stand these enormous reductions of rates and at the same time increase the net operating income earned by them. The trend of operating costs, after having been steadily downward for some years, now seems in danger of being arrested by advances in wages, and increases in taxes also continue to occur. Thus far the public has been the principal beneficiary of the improvements made in operation, because they have resulted in better service and also have made possible the savings in rates mentioned, which have largely exceeded the increases in net operating income that have been secured by the railways for themselves. It is plain that if the downward trend of operating costs is arrested the decline of rates will have to stop or the effects upon the net return earned by the railways will be serious.

Another Case of the Tail Wagging the Dog

THE Interstate Commerce Commission recently rejected the plan for a combination of control of the Kansas City Southern, Missouri-Kansas-Texas and St. Louis Southwestern largely on the ground, at least so far as emphasis was placed in the report, that the smaller of the three companies, the Kansas City Southern, was proposed as the controlling factor. It was held that the control of properties so large by such a relatively small amount of capital would not be in the public interest. Since then the commission has made public a proposed report by Examiner Ralph R. Molster recommending a denial of the application for a unification of the New York Central, Big Four and Michigan Central and subsidiary properties aggregating 11,507 miles of main line, solely on the ground that provision had not been made for including a number of independent connecting short line railroads aggregating about 500 miles. While several other issues were involved in the case, including a strenuous controversy as to the terms and conditions of the leases proposed, and although a unification into a single operating unit of this size ought to be either a good thing or a bad thing for a number of fairly important reasons, the report gives conclusions or recommendations on but one of the points involved. The practical effect of the 49-page report is to point out to the commission that here is a case where the New York Central is asking for something which it apparently wants and it is too good a chance to pass up to require the New York Central to do something to help solve the short line problem. Just as the commission saw in the Kansas City Southern capital structure "too small a base upon which to build such a financial pyramid," the conclusions stated in this report seem to afford rather a small base upon which to decide a case of this importance and magnitude. Undoubtedly it is true that the desire to find an asylum for many of the short lines, meaning lines "short" in revenues more particularly than those having little mileage, was one of the reasons

Congress had for enacting the consolidation provisions of the transportation act, but certainly the short lines were not the only ones mentioned in the act.

Better Track Circuit Operation at Lower Cost

THE constant emphasis that is being placed on economy in all phases of railway operation is reflected in the improved signaling facilities which are available today. By making automatic signal installations more economical to maintain, without in any way sacrificing their operating value, a greater inducement is offered for increasing such facilities. Until the introduction of low resistance bonding for signal track circuits little effort was made to reduce track circuit operating costs, although the track circuit is the backbone of any automatic signal installation and anything which will substantially lower its current consumption will effect a sizeable reduction in signal operating expenses. E. N. Fox, general signal inspector, Boston & Maine, and chairman of the committee on Direct Current Automatic Block Signaling of the Signal section, A. R. A., in an article in the June issue of Railway Signaling, pointed out that recently developed track relays will effect a saving of one third in current with an increase in shunting efficiency (ability to protect trains) ranging from 23 to 262 per cent, according to certain tests made under varying conditions of ballast resistance. "As to current economy," Mr. Fox states, "there can be no question concerning the superiority of the new types of relays. It will readily be apparent that on a properly adjusted track circuit the current saving will be appreciable." A reduction in relay working current (normal current with track circuit unoccupied) such as is now possible will cut primary battery renewal expense appreciably and at the same time increase the safety features of the track circuit.

Is Money Spent for Advertising Wasted?

A YEAR ago Henry Ford decided that advertising is an economic waste, and stopped the spending of money by the Ford Motor Company for this purpose. A few weeks ago a Detroit newspaper announced that the Chevrolet company had displaced Ford as the builder and seller of the largest number of automobiles for the first time in history. A few days ago the Ford Motor Company retained an advertising agency, and it is now about to launch an advertising campaign in which it is expected to spend several million dollars. Is advertising an economic waste? The Ford Motor Company seems to have changed from a position in which its answer was, "Yes," to one in which its answer is, "No." The cost of advertising, it apparently has found, is today the price of business success. This is true of the automobile business and it is just as true of the railway business. There is no great difference between the two. Both sell transportation, which is partly an essential and partly a luxury. What put the Chevrolet company in the lead was largely its advertising. This year it is spending $10,000,000 on this account. What if a railway should spend as large a proportion of its gross revenue for advertising as the Chevrolet company spends of its gross sales? If advertising can sell an automobile with a certain name on it, as it can and does, it can sell a railway ticket with a certain name on it. Compared with other sellers of commodities, the railways as a whole spend very little in advertising the commodity that they sell, transportation. It is highly significant, however, that more railways are advertising as time goes on, and that they are spending more money for larger and better advertisements.

Cross Crossings Cautiously

WITH 2,500 lives sacrificed at highway crossings in a single year, every railroad officer is, of course, disposed to do everything that is reasonably within his power to put a stop to the slaughter, regardless of the fact that the railroad company rarely, if ever, is responsible for these disasters. The railroad officer has a responsibility as a citizen, as do other citizens; and, because of his better knowledge, perhaps a heavier responsibility. President Frank H. Alfred of the Pere Marquette, in a poster-circular, appealing to women, calls attention to the need of considering *all highway accidents* which happen to, or because of, automobiles. Looking at the causes, this would seem to be a very sensible view. *Sixty-five times as many* casualties occur at other points on the highway as at railroad crossings. Classifying causes with precision is, of course, out of the question. Lectures on causes are worthless except as they reach the minds of the persons who are likely to take risks at crossings in the future, and no one knows how to pick out those persons. This being the situation, the logical course is to give education in safe habits to everybody; and in this, as Mr. Alfred observes, women, who can influence their sons and daughters (and, says the circular, their husbands) can undoubtedly do much good. To address admonitions to 100 persons when 6,500 are in need of the same lesson, is a misuse of energy. Or, to put it another way, the need for "missionary work" calls for 65 persons to conduct the propaganda, instead of one person, as might seem to be the case, if attention were given only to the railroad-crossing problem. Any one desiring to preach "Cross crossings cautiously" is in duty bound to pool his efforts with those of the 65 other persons who may be assumed to have in view substantially the same object and who, presumably, are appealing to about the same class of persons. Mr. Alfred's circular is noticed on another page.

Co-operation from the Universities

THE Mechanical Division was fortunate this year in having two papers on its program presented by engineers well known in the field of railway educational activity—Dean A. A. Potter of Purdue University and Professor Wood of Penn State. Both papers contained a number of suggestions relative to the utilization by the railroad industry of technically trained men and the experimental and research facilities of the various educational institutions and existing technical organizations. Both Dean Potter and Professor Wood showed into what lines of industrial activity recent graduates in engineering were going; it is quite evident that the railroads are not getting their share of these men. Undoubtedly one of the principal reasons for this is that the railroads have made comparatively little attempt to utilize men of technical education. On the other hand, the railroad industry, through the American Railway

Association, is utilizing the experimental and laboratory facilities afforded by the colleges and universities; witness the air brake and draft gear tests now being conducted at Purdue. Some of the functions of a bureau of investigation or research, as suggested by Professor Wood, are therefore already being accomplished through existing agencies.

There is some question as to the advisability of attempting to concentrate all of the Mechanical Division experimental and research work at one institution. The majority of the technical schools and universities have stronger faculties for, and are better equipped to handle, certain specific lines of investigation than they are to handle others. The assigning of research work to institutions located in different parts of the country will create greater public interest and will tend to create interest in railroad work on the part of a larger number of engineering students.

Improved Equipment Maintenance

"SINCE the beginning of the present century the expenses of maintaining equipment have increased relatively much more than other expenses, but the additional expenses in maintaining equipment have purchased economies of much greater magnitude in transportation." This statement was made by Prof. William J. Cunningham of Harvard, in his address before the Mechanical Division meeting at Montreal on Friday of this week.

Twenty-five years ago, with comparatively low labor and fuel costs, the design and construction of the locomotive was plain and simple. Economic urge—intensified in the railroad field by restrictive regulation and legislation—gradually forced the railroads to larger and larger locomotive capacities, and to a considerable number of refinements in design and construction which complicated the problem of maintenance but fully justified themselves from the economy and efficiency standpoints.

The mechanical department officers of a very few roads—two or three—who twenty years ago insisted upon special pains being taken to insure the cleanliness and neat appearance of the locomotives, were regarded as just a bit eccentric. The effect, however, upon the morale of those who operated the locomotives, and in various other advantages of improved maintenance, fully justified their position. Indeed, today it is not only more or less generally understood that it is more economical to maintain the power in first-class condition, but not a few managements actually take pride in decorating some of their locomotives and in making all of them look more attractive. Not only does this appeal to the public, but the claim is made that the expense is far more than justified in various ways because of the improved service and the resulting benefits both to the shipper and to the railroad.

Twenty-five years ago steel hopper and gondola cars were coming into use in increasing numbers on a few of the railroads which specialized in the handling of coal and ore. It was not until many years later, however, that the problems of maintaining this type of equipment were understood, and any adequate provision made for its maintainance and repair. Substantial progress has been made in this direction in recent years and much has been done to repair and rebuild these cars, as well as other types of freight equipment, on a schedule or mass production basis. Incidentally, the recognition that freight cars should be scheduled for rebuilding at regular intervals in the interest of safer and more economical operation was no small factor in bringing about the introduction of mass production methods in rebuilding.

One of the greatest factors in bringing about an improvement in the design and maintenance of box cars was the awakening to the large wastes in loss and damage to freight caused by the use of defective equipment. A series of articles on this question, published in the *Railway Age* about 15 years ago, was an important factor in focusing attention on this point. Several years later, when the railroads were confronted with an abnormal traffic during the war, railroad managements were also forced to recognize the necessity of maintaining the freight equipment in the best possible condition at all times, not only to meet emergencies, but to insure stability of service. It is significant in this respect that the American Railway Association, in setting up its program for improvements in operation a few years ago, included among its goals certain minimum percentages of bad order cars and locomotives. Undoubtedly, this had not a little to do in the speeding up of the freight service and improving its dependability. Not only did it reduce the loss and damage to freight and the number of accidents and delays, but, in effect, it added the equivalent of thousands of cars and hundreds of locomotives to the serviceable equipment, making it possible to handle a steadily increasing traffic with a decreasing number of units.

While it is true that there were many other factors involved, such as the providing of better and more extensive facilities at great expense, fundamentally the greater care given to the maintenance of equipment undoubtedly formed the basis for much of the remarkable improvement that has taken place in the utilization of equipment in recent years.

The Georgetown Loop

NO single example of railway location is more widely known than the Georgetown loop line of the Colorado & Southern in Colorado. For years pictures of the loop adorned the walls of many a passenger station throughout the country. It has been repeatedly described and illustrated in text books on railway engineering and was subjected to critical analysis by Wellington in his classic treatise on railway location. But while it has been frequently set forth as an example of an ingenious solution of a difficult problem in location in which four miles of development on a 3.6 per cent grade was employed to make a climb of 605 ft. from Georgetown, Colo., to Silver Plume, the western terminus of the line, it has never been of great importance as a piece of railway property. Built in the early eighties as a narrow-gage branch by a subsidiary of the Union Pacific when development in metal mining in Colorado was at its height, it has suffered the fate of many other lines in the Colorado Rockies. Efforts to capitalize on the scenic attractions of the line, in which the loop itself was no small drawing card, were successful for a time in producing revenue from passenger service to compensate for the decline in freight traffic.

But the growing popularity of motor vehicles and the improvement of highways eventually made serious inroads in the passenger earnings, and as reported elsewhere in this issue, the Colorado & Southern has been granted permission by the Public Utilities Commission of Colorado to continue all passenger, baggage and ex-

press business over this line for a test period of one year. Considered as a branch line railroad on which passenger service has been discontinued by reason of loss of traffic, the 54-mile line from Denver to Silver Plume is of no more importance than any other branch line of similar length. But as a line which embraces a piece of engineering that has long lent picturesque interest to the field of railroading, its passing is sure to be a source of regret.

Freight Car Repair Shops

IN submitting this year's report the Committee on Shops and Engine Terminals has placed on record a suggested design for freight car repair shops, which, while not adaptable to all conditions, lays down enough of the fundamental requirements of such design to serve as a valuable guide to those planning new facilities. Two years ago, when instructed to prepare a report on freight car shops, this committee recognized the trend in freight car repair methods, which is evidenced by the fact that the recommended shop design is well suited to practically all methods of car repair work, but is especially adapted to the handling of work by the progressive system. The extent to which this system has been adopted—reports now indicate that over 50 per cent of the country's freight cars are repaired under this system—indicates that the railroads are alive to the possibilities of benefiting by the experience of other industries in the adoption of quantity production methods.

The introduction of the progressive car repair system on American railroads has demonstrated a possibility, the importance of which has probably not been generally recognized. As stated in the discussion of this report by a representative of one of the large roads which was among the first to adopt this system, it has made possible the repairs to some ninety thousand freight cars by that one road and carried it through periods of peak equipment demands without building any new freight car repair shops. In fact, during this period it has been possible to abandon a number of shops not suitably equipped for the repairing of modern equipment.

The progressive repair system, as thus far developed, lends itself naturally to the better handling of freight car repairs with the use of the present facilities. It is possible that the Committee on Shops and Engine Terminals could profitably give some study to the problem of modernizing existing facilities for the more economical handling of car repairs by modern methods; this might result in the accomplishment of the same purpose with a considerably smaller capital investment.

The Montreal Convention

CONVENTIONS, like persons, have individual qualities. Some develop an atmosphere of dull formality; some are sentimentally garrulous; some are breezily full of "pep." Occasionally one develops a quality which in a person is best described as perfect poise. In it are compounded dignity without pompous formality, courtesy and good feeling without insincere sentimentality, a quiet seriousness which is not devoid of a touch of humor, and an unhurried effectiveness in the dispatch of the day's work. Such a convention was that of the Mechanical Division of the American Railway Association, held at Montreal, Que., Tuesday, Wednesday, Thursday and Friday of this week. Many things contributed to this pleasing result. There was the hospitality of Canada, its railroad men, and the city of Montreal. There was the comprehensive and forward-looking character of the convention program and the completeness of the advance preparation of papers and committee reports. There was the constructive spirit of the addresses—even the invocation carried a thought-provoking message.

The Mechanical Division is an organization, the major work of which involves a tremendous volume of intricate and technical details, which have to do with the smooth functioning of an important part of the transportation machine. If, however, the character of this year's program is an indication of a trend in the development of the organization, it clearly promises a future in which the competent handling of the major task of the organization will no longer be allowed to crowd out time for thought of the future. From the thoughtful consideration and discussion of such papers and committee reports as those dealing with the future possibilities of steam locomotive development, and the status of oil and gasoline engines as railway motive power, practical applications will undoubtedly develop on a sounder basis than would be possible if this organization were to consider its job completed and its responsibility discharged by the revision of rules, specifications and standards. The discriminating sense of relative values indicated by this program is in no small measure responsible for quality of poise felt by those who attended the Montreal convention.

Specifications Prove Valuable

STANDARDS and specifications developed by the Mechanical Division of the American Railway Association are coming into more common use and saving the railroads substantial amounts of money each year. Practically no new box cars have been built in the last two years that do not conform essentially to A.R.A. standards, and in a few years, when car manufatcurers have more generally supplied themselves with the patterns, jigs and templates used in making standard cars, railroads requiring details which differ from the standards will have to pay a high premium for their individuality. The additional price of non-standard car material is apparent to a degree even at the present time.

With the co-operation of the manufacturers, the Mechanical Division has developed specifications for many other materials which are workable and mutually agreeable to the manufacturers and the railroads, and the more general use of which will tend to assure the railroads receiving better materials at substantially lower unit costs. These specifications cover such materials as steel castings, springs, boiler steel, galvanized sheets and rubber goods shown in Section A of the Manual of Standard and Recommended Practice.

An example of the way in which standard specifications work to the advantage of the railroads is afforded by experience with the purchase of rubber goods, such as air, steam and water hose. A year or two ago only four or five railroads used the A.R.A. specifications in ordering this equipment, whereas a recent analysis shows that a substantially greater number of roads now use these specifications, or purchase manufacturers' brands which have already been standardized and perfected by the manufacturer for the particular purpose intended. The fact is brought out in this analysis that 23 important railroad systems now use the A.R.A. specifications or brand method in ordering braided air hose; 22 railroads, wrapped air hose; and 21 railroads, steam and water

hose. There is still need, however, for greater co-ordination of detail material specifications used by some railroads, in order that manufacturers may not be required to treat every order received as a special one and thus increase production costs and, consequently, the price of goods purchased by the railroads.

A Hopeful Indication

THE rail problem is not new to the railways. It has been before them intermittently for years in one form or another. It has been particularly conspicuous since the transverse fissure was first discovered in 1911. Much study has been given to the defects in this fundamentally important unit of track construction and some improvement has been made. But the more serious defects still remain and not a few railway men admit discouragement regarding the progress that has been made up to the present time in the discovery of means for the elimination of these defects.

Within recent weeks, however, there have been certain indications that a development is taking place which, while not yet productive of specific results in itself, holds much of promise. In the past the study of rail defects has been retarded by the lack of co-operation between the representatives of the mills producing the rails and the representatives of the railways which use them, and each has frankly placed the responsibility for the deficiencies on the other. Under this condition the work that has been done has been largely defensive and this attitude has accounted in large measure for the lack of progress in the discovery of the conditions contributing to these defects. Of late, however, there are indications that point to a change in this attitude.

Only a few days ago a leading western railway approached a mill from which it purchases large tonnages of rails annually with the request that it conduct certain experiments in mill practice to determine the effect, if any, of certain of these practices on the production of transverse fissures. Instead of opposing these tests, which of necessity resulted in extra effort and cost on the part of the mill, the road was met with open arms and its suggestions were not only accepted but were amplified to cover the study of still other conditions that the mill men believed worthy of attention. Throughout the conduct of the tests the mill men showed an interest in the outcome equal to or even greater than that of the railway men. Another rail manufacturer has just taken an engineer of experience and standing in railway work into its service to interpret the railway viewpoint to its officers and in turn to interpret the mill problems to the railways, thereby establishing a liaison between the manufacturer and its customers. By measures such as these the mills can do much to close the breach between them and their largest customers and thereby go a long way in the solution of their mutual problems, which each has been studying from an incomplete and from a prejudiced viewpoint for a number of years.

The railways of the United States alone spent over $110,000,000 for steel rails last year. This large sum was divided among only ten mills. It therefore constituted a large and concentrated business for them. Entirely aside from the commercial aspect, however, a manufacturer of necessity shares responsibility with the railways for the delivery of a product of such quality that its use will not subject the public at large to unnecessary or unreasonable hazard of travel. The making of rails is essentially a metallurgical problem. The steel manufacturers are of necessity experts in metallurgy and are naturally more thoroughly versed in the production of steel to meet a specific service than anyone in the employ of the railways. With the greater interest that is now being displayed on their part in the problems of their largest customers, we may look for improvement in the near future in the problem of producing rails to meet the requirements of these customers.

The Dilemma of the Railways

THE attitude and policy of the Interstate Commerce Commission, which recently have been strikingly illustrated by the decision, a majority of its members in the O'Fallon Railway valuation case, present to the railways a difficult and disagreeable dilemma. They must take either the risk of antagonizing the commission by critically discussing its policy in public or the risk of having its policy made the nation's permanent policy of regulation.

The commission is an administrative body deriving its authority from laws it is charged with carrying out. A majority of its members, in the decision mentioned, took the position that some of the most important provisions of these laws are unsound as a matter of public policy, and therefore should not be carried out. It is beyond dispute that under decision of the Supreme Court, and also under the LaFollette valuation act, the commission is required to give effective weight to present cost of reproduction in its valuation of all railway property. That a majority of its members refuse to do this is tacitly conceded in the majority opinion and expressly asserted in the dissenting minority opinions. While the majority decision has been commended by radicals in both private and public life, no statement to the public criticizing it has come from any person or organization officially authorized to speak for the railways. An appeal from it to the Federal courts has been made, but, of course, the papers in this proceeding are intended to enlighten the courts rather than the public.

Typical of Past Developments

This is typical of what has been occurring almost ever since the Transportation Act went into effect. That act was passed, first, to return the railways to private operation, and, secondly, to cause changes in their regulation that would assure better opportunity for successful private management. The Commission has persistently failed to give effect to the rate making provisions of the act. Although the last four years were a period of unusual prosperity in the east and south, no large groups of railways earned during this period an average of 5¾ per cent annually on the Commission's own tentative valuation, which is based mainly on pre-war costs. The railways of the western district have not earned such a return in any year. The rate-making provisions were plainly intended to allow the railways to earn larger returns than before the war, but most of them have earned smaller returns. Nevertheless, the Commission's administration of the law has received so little public criticism from official spokesmen of the railways that in the majority opinion in the O'Fallon case their silence and failure to appeal to the courts were used as evidence that they acquiesced in the justice and wisdom of the Commission's policy.

The failure of railway executives publicly to condemn the policy that has been followed by the Commission can be easily explained. They have believed until recently that it has really intended to administer the interstate

commerce law in accordance with its plain intent, and has been prevented from doing so only by conditions resulting from the deflation following the war and by the sentiment in certain territories due to these conditions, and that, it would be better to trust it than to antagonize it by criticizing it and appealing to the courts. The net return of the railways as a whole has been increasing; some roads have been becoming fairly prosperous, and it has been anticipated that final valuations would be made in accordance with existing law. The comparative prosperity of some railways has disposed their managers to conservatism and optimism in their utterances, and the executives of average and poor roads naturally have not been disposed to take alone the risk of criticizing a body which has so much power over them, especially when so many consolidation projects have been under consideration.

A Situation Not Previously Recognized

The decision in the O'Fallon case reveals the existence of a situation which had not previously been recognized. It is revealed not merely by the decision itself but also by the reasoning by which it is supported. The situation revealed is that already mentioned, viz., that a majority of the commission believe that some of the most important principles of the present interstate commerce act are unsound as a matter of economics and public policy and refuse to act in accordance with them.

The issues presented in the O'Fallon case will be fought out in the courts, but experience during the last twenty years, and especially during the last six, shows that court decisions and statutes will not determine regulation, but that it will be determined mainly by the attitude of members of the Interstate Commerce Commission. The nation has laws intended to perpetuate private ownership and management and to give them an opportunity to be successful. The advocate of private ownership concedes that under government ownership capital could be raised at a lower rate of interest, but contends that under private ownership management is better and operation more economical. The advocate of government ownership emphasizes the low rate of interest at which capital could be secured under that policy and depreciates or denies the greater enterprise and efficiency of private management. Anybody who reads carefully the opinions of the majority of the commission in the O'Fallon case will detect that their reasoning is based on the major premise that the main object of regulation should be to strictly limit the return earned on capital in the railroad industry. The effect that the return earned may have on the provision of adequate transportation is noticed, but nowhere is reference made to the effect it may have under private ownership on improvements needed to assure the greatest practicable economy in operation. Nowhere is there any recognition of the fact that it is just, or desirable as a matter of public policy, for the owners of railways to receive relatively as large returns on their capital as the owners of other kinds of property. In other words, although the main purpose of the Interstate Commerce Act is to establish a policy of regulation that will be fair and beneficial to the public and assure the continuance of private ownership as a means to that end, the economic philosophy of a majority of the present members of the commission is in the main that of the advocate of government ownership. If evidence of this were needed, in addition to what appears in the opinions in the O'Fallon case, it is afforded by the endorsements of the majority opinion that have been given throughout the country by those who advocate government ownership.

If the executives of the railways criticize the policy of the majority of the Commission they will antagonize it. If they criticize it now, when many railways are earning substantial returns measured by prewar standards they may give the public the impression that they are complaining when they are not being hurt, although this would certainly not be true as to the western roads.

Jeopardizing the Future

On the other hand, if they do not speak frankly they may jeopardize the entire future of the railway industry. The railways of the east and south were, for some time, earning comparatively large net returns, but the effect quickly produced under present conditions by a decline in traffic is illustrated by the large decline in the net earnings of the southern roads that has occurred within recent months. The western lines last year handled a slightly larger freight business than ever before, but still fell far short of earning a fair return measured by any standard. Owing to advances in wages operating expenses are increasing. The ratio of operating expenses and taxes to gross earnings is still much higher than before the war, and, in spite of a general impression that the railways are unusually prosperous, it is evident that a substantial decline of traffic would soon destroy their seeming prosperity.

The net return earned in good years by most roads must be larger than it is now if the average return earned over a period of years is to approximate what the Commission has held would be a fair return, or even remotely approach a fair return on a valuation giving effective weight to present costs of construction. It is, however, plainly the policy of the majority of the commission not only not to let the railways earn anything approaching a fair return on a valuation giving effective weight to reproduction cost, but also not even to let them earn in good years a return sufficiently in excess of a fair return on its own basis of valuation to compensate for the deficiency incurred in poor years.

Confronted with this situation, it does not seem sound policy for those who can speak authoritatively for the railways to the public to refrain from doing so. The public is entitled to know all the facts. Having got substantially the policy of railway regulation that they advocated in running the La Follette-Wheeler ticket in 1924, and almost exactly the kind of valuation decision from the Commission that they wanted, the radicals in private and public life will now laud the Commission as an expert and impartial body, and denounce the railways for appealing from its valuation decision to the courts. There is grave danger that unless the Commission's policy is fully explained and exposed by railway spokesmen it will become the nation's policy of regulation instead of that provided for by the laws which the Commission is charged with administering.

The leader of the majority of the Interstate Commerce Commission is Commissioner Joseph B. Eastman of Massachusetts. In a speech advocating government ownership, which he delivered before the Boston Chamber of Commerce on November 30, 1920, Commissioner Eastman said: "I have no faith in the magic of any legislation or of any policy. This is a government of laws and not of men, but the man behind the law is as vital as the man behind the gun. No railroad policy will succeed without the support and earnest effort of the people of the United States." The men behind the federal laws regulating railways are the members of the Interstate Commerce Commission. Unless there is a change either in the personnel or the policy of a majority of the commission, our national policy of private management and government regulation will fail again, as it did before the war, and railway conditions within a few years will be similar to those which in 1917 precipitated the adoption of government control.

The Lift Span Fully Open—Note the Machinery Houses at the Tops of the Towers

A Lift Span of Unusual Design

Rock Island structure over White river embraces many departures from current practice

IN rebuilding a bridge over the White river at De Valls Bluff, Ark., the Chicago, Rock Island & Pacific replaced an old swing span with one of a vertical lift type that embraces a number of distinctive departures from current practice in movable bridges of this character. Among the unique features of the design is the elimination of independent haulage lines for lifting and lowering the span, movement being accomplished, as in elevators, by a direct motor drive to the counterweight sheaves. This arrangement calls for separate power units on each tower and introduces the possibility of unequal travel of the two ends of the span, a contingency which has been met in an effective manner in the arrangement of the control apparatus. The train of equalizer beams usually provided at one end of each group of counterweight ropes has been supplanted by hydraulic equalizers, by means of which all ropes were subjected to equal tension before the bridge was placed in service. Longitudinal struts near the top of the towers have been designed to serve as girders of adequate strength to carry the full load of the counterweights so that loose I-beams stored on these struts (clear of the counterweight travel) may be slid into position to carry the counterweight at any time that it is necessary to facilitate maintenance operations requiring the load to be released from the counterweight ropes.

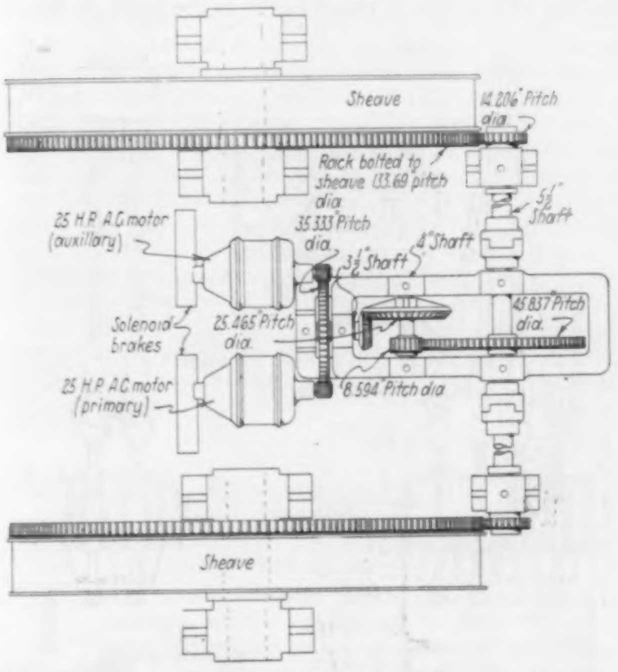
The replacement project was the result of inadequacy and obsolescence of the old structure, of which the piers date back to 1870 when the Memphis & Little Rock railroad, now a part of the Rock Island, was completed by the construction of a bridge across the White river. The original Howe trusses were replaced in 1899 by pin-connected through spans. As thus rebuilt, the old bridge consisted, from east to west, of a swing span 219 ft. 7½ in. long and three fixed spans of 146 ft. 4 in., 147 ft. 11 in., and 150 ft. 2 in., respectively, on the original stone masonry piers. This structure was flanked on the east by 92 panels of ballast deck creosoted pile trestle and on the west by 52 panels of the same construction.

The White River Bridge as Seen From the East End

This old bridge, as well as the one which now replaces it, were built to carry a single track.

Why the Bridge Was Rebuilt

While the old superstructure was of limited capacity as compared with present day requirements, the primary consideration leading to replacement was the failure of the old piers through the cracking of the bridge seats



Arrangement of the Direct Motor Drive to the Counterweight Sheaves at the Top of Each Tower

and the masonry immediately below them and instability resulting from disintegration of the cofferdams supporting the rock fill on which the piers rested. Piers 4 and 5 under the fixed spans were rebuilt first, and later, when it was found necessary to renew Pier 3, which supports the west end of the old draw span and the east end of the adjacent fixed span, it was decided to replace the draw span. Negotiations with the United States War Department for authority to rebuild the bridge led to the approval of a plan for a vertical lift span affording a clear waterway opening of 175 ft. between faces of supporting piers with a clear lift of 55 ft. above high water. This required the construction of a span 182 ft. 4 in. long center to center of end bearings and with a vertical lift of 55 ft., with new flanking spans 147 ft. 3 in. long to carry the necessary towers. This plan, therefore, provided for the entire replacement of the old draw span and the fixed span to the west of it, as well as a portion of the approach trestle to the east of it. The change in the span arrangement necessitated the construction of piers at new locations under the east end of the new lift span and at the east end of the east fixed span. The work carried out under this plan was completed on January 15, 1927, and it is proposed to replace the two remaining old spans within a short time.

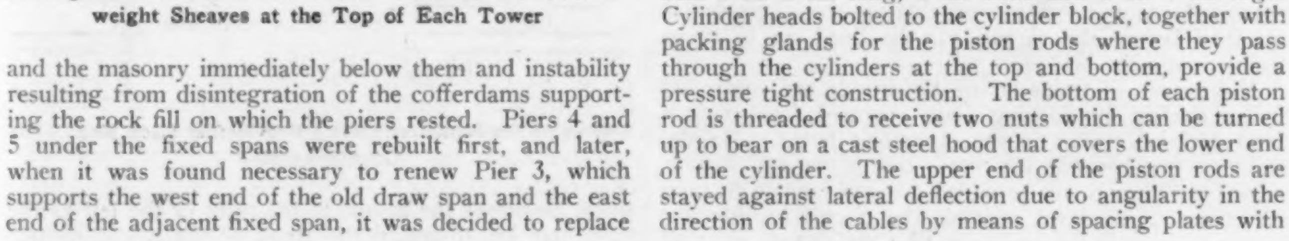
The new spans are through riveted trusses of the subdivided Warren type, the fixed span having 12 sub-panels 12 ft. 3¼ in. long and the lift span 16 sub-panels 11 ft. 4¾ in. long. The trusses are 18 ft. 6 in. center to center and the bottom and top chords are 33 ft. center to center. The fixed spans have creosoted timber ballasted floors and the lift span a standard open floor. The end floor beams of all three spans are designed as lifting girders by means of which the spans may be lifted clear of their bearings on jacks if necessary.

Each corner of the lift span is suspended by means of eight Monitor steel ropes, 1⅝ in. in diameter, furnished by the American Steel & Wire Company, Chicago. These ropes are carried up over cast steel sheaves 11 ft. in diameter to connections with counterweights consisting of structural steel boxes filled with concrete. The weight of each counterweight is 361,470 lb. or one-half the weight of the movable span complete.

Provide Hydraulic Equalizers

To effect a connection with the counterweight, the eight ropes at each corner terminate in socket clevises which are connected by means of pins to piston rods that pass through eight cylindrical openings cast in a steel box 3 ft. 6 in. long, 2 ft. wide and 1 ft. 4 in. high. Cylinder heads bolted to the cylinder block, together with packing glands for the piston rods where they pass through the cylinders at the top and bottom, provide a pressure tight construction. The bottom of each piston rod is threaded to receive two nuts which can be turned up to bear on a cast steel hood that covers the lower end of the cylinder. The upper end of the piston rods are stayed against lateral deflection due to angularity in the direction of the cables by means of spacing plates with slotted holes. Steel plates 22 in. wide by ¾ in. thick, providing a connection between the cylinder blocks and a short equalizer beam, which is in turn connected to the counterweight hangers by a 4-in. pin, complete the connection between the counterweight ropes and the counterweight.

After the entire counterweight system had been as-



The New Superstructure of the White River Bridge in Relation to the Spans it Replaced

sembled and the nuts on the piston rods had been turned up tight, pressure was applied to the tops of the pistons by means of a light oil thinned with kerosene delivered through ¼-in. feed lines from a high pressure pump. Falsework under the counterweight was then removed and pressure increased until all of the nuts on the piston rods were loose. Then with the pressure maintained, all nuts were turned up to a snug bearing, thus holding each rope to the uniform tension set up by the hydraulic pressure.

Direct Motor Drive on Sheaves

Bolted to one side of each of the counterweight sheaves is a segmental geared rack which meshes with a pinion gear that is connected in turn through a train of gears to two 25-hp. alternating current motors, so arranged that the machinery may be operated by either one or both of the motors. Each motor is equipped with a solenoid brake mounted on an extension of the motor shaft. The motors as well as the brakes are subject to control from an operator's house located outside the trusses at one end of the lift span and by a limit switch operated by a worm gear from the pinion shaft.

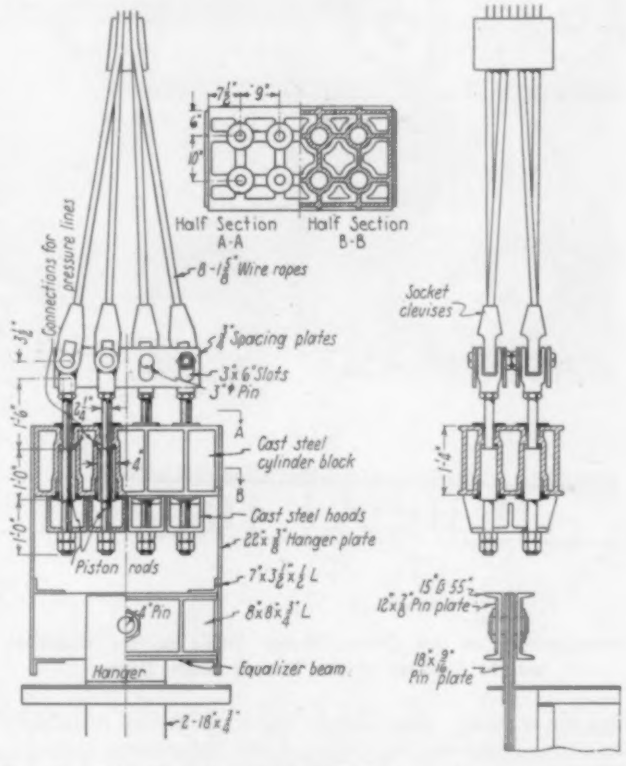
Stopping of the movement of the span at the top and bottom of the vertical travel is cushioned by means of air buffers, those on the piers which receive the span in its down travel being 2 ft. 9¾ in. long by 10 in. in diameter and those at the top of the towers to cushion the upward movement are 2 ft. 8 in. long by 9 in. diameter. A beveled tongue type of bridge lock is provided on the bottom of each end floor beam to center the span as it closes by entering a slot in a casting mounted on each bridge seat. The rail lock is of the easer tongue type. The tongue comprises a projection of a steel casting bolted to the ties on the movable span and extending out onto the fixed span where it seats in a slot formed in a casting attached to the ties of the fixed spans. A plunger lock insures that positive alinement is obtained before the signals can be lined up to move trains across the bridge.

Movements of trains across the bridge are controlled by an electric interlocking plant operated from a deck lever type controller in the operator's house. No derails or smashboards are used, but home and distant color-light signals are provided for movements in both directions. One lever controls the circuit breaker for power to operate the bridge so that the signals must all be at the stop indication before the bridge can be opened. Similarly, when the bridge is closed the bridge locks and rail locks must be in correct position before the signals can be set to indicate proceed.

How the Operation Is Controlled

Power for the operation of the bridge is taken from a 13,000-volt power line of the Arkansas Light & Power Company and is delivered to the motors as 440-volt, 3-phase, 60-cycle current. The bridge operating control equipment includes a master controller, a leveling controller, a brake controller, a selector controller for each of the four motors, and a foot release. The indicating equipment consists of a board equipped with a dial having a pointer showing the relative elevations of the two ends of the span and five jewel type lights arranged as follows: Two lights at the bottom which show white when both ends of the bridge are down, a light above these which shows red when the bridge is nearly down, a second light which shows red when the bridge is nearly open, and a top light which shows green when the span is fully open.

To raise the span, the following sequence of operations is carried out: The interlocking signals are set at stop, thus making power available for the opening of the bridge. The brake controller is set in the release position. Two of the motor selector controllers are set in the on-position, that is, one for a motor at each end of the bridge. Following this the handle for the master controller is moved progressively through the eight points to release the brakes and accelerate the motors to full speed. With the bridge in motion, the operator places his hand on the handle of the leveling controller and watches the level indicator to check any tendency for one end of the span to travel faster to the other, in which



Details of the Equalizer Device Provided at Each End of the Counterweights

event he moves the handle to the right or the left as the case may be, to retard the speed of the motor on one tower or the other.

Limit Switches Cut Power Off

A similar sequence is carried out in lowering the span. When the span reaches a point 3 ft. from the upper or lower limits of its travel, the limit switches cut off power, stopping the motors and setting the brakes. To complete the movement, the operator must return the handle of the master controller to off-position, following which he may make use of the foot release to regain use of the controller, but this operation gives him only the first four points of acceleration so that the movement to fully open or fully closed positions is at slow speed.

Failure to keep the two ends of the span level, with a resulting excess in the relative elevation of one end over the other, also results in an automatic shut-off of power which is again made available under limitations as explained above.

The construction of the new piers, particularly the replacing of the old piers, was attended by much difficulty, because it was necessary to support the spans on falsework while the old piers were removed and the new ones were built. To do this it was necessary to carry the ends of the bridge spans on girders spanning longi-

tudinally between bents driven on each side of the old pier. In order to put these girders into position it was necessary to cut notches through the top of the piers, an operation which had to be carried out with extreme care because of the shattered condition of the upper portion of the pier masonry. A detailed account of the manner in which this work was handled on two of the piers was given in an article appearing in the Railway Review of August 26, 1923, page 259. The removal of the old steel and the erection of the new was carried out on falsework in accordance with commonly accepted practice. The sub-structure work was done by the Bates & Rogers Construction Company of Chicago. The structural steel and operating machinery were fabricated by the American Bridge Company and erected by the Kansas City Bridge Company, with the exception of the control and electrical equipment which was installed by the American Bridge Company. The design and construction of the bridge was under the direction of I. L. Simmons, bridge engineer, Chicago, Rock Island & Pacific, and under the general supervision of C. A. Morse, chief engineer. S. T. Corey, assistant bridge engineer, supervised the design and Bert Matheis, chief bridge inspector of the railroad, supervised the construction.

Accident Investigations in Month of January

THE Bureau of Safety, Interstate Commerce Commission, in the month of January, 1927, investigated three collisions and two derailments. Abstracts of the reports on these accidents are given herewith:

Texas & New Orleans and Port Terminal, Houston, Texas, January 7., 9:40 p.m.—A westbound freight transfer of the Texas & New Orleans, standing on the crossing of the Port Terminal Railroad Association, was run into by a northbound freight transfer of the Port Terminal, and the conductor of the last mentioned train was killed. This train consisted of 21 cars, being pushed by M. L. & T. locomotive No. 83, at very low speed; and the conductor who was killed was riding on the top of the leading car. The immediate cause of the collision was the inability of this man and of the brakeman with him, to see the train which stood in their path. This train consisted of gondola cars and the men, seeing switch lights beyond the crossing, assumed that their track was clear. The inspector gives the cause as the failure of this train to stop before crossing, which failure was a violation of the rule; but witnesses seemed to think that the men would have failed to see the cars ahead of them, just the same, even if they had stopped. The rule requiring all trains to be brought to a stop before passing over this crossing, had been often ignored by employes with the full knowledge of the officers. The superintendent seems to have thought that very low speed answered the spirit of the rule as well as a full stop; but the report calls attention to a similar collision which occurred on the Houston Terminal on September 13, 1922. On the whole, the inspector places no censure on the individual members of the crew but says that, rather, the responsibility should be placed on the officers. Both of these trains were being operated without the use of air brakes and both were thus violating the law; moreover, a violation of the same kind was reported in the case of the collision of 1922. With the exception of the engineman, who was at the rear of the Port Terminal train, all of the members of the crew were inexperienced.

Missouri Pacific, New Haven, Mo., January 13.—Work train No. 2654 moving west at low speed, collided with work train CJL-10 which had preceded 2654 by a few minutes but which had stopped and was moving backward. One engine and several cars were badly damaged and the engineman of CJL-10 was killed. Also, one construction company foreman was killed and seven men were injured. Both trains had orders to work within certain limits and to protect against each other, and both are held to blame. No. 2654 was to pass the other but the conductors did not have a definite understanding, nor did either fully inform his engineman.

Southern, Lindale, Ga., January 14, 7:43 p.m.—Northbound passenger train No. 2, consisting of locomotive No. 1466 and ten cars, was derailed at a misplaced switch and the engineman was killed. The switch apparently had been tampered with, the light having been taken off and hidden; but the turnout was a No. 10 and the locomotive seems not to have left the rails until it struck a derailer which was on the rail of the side-track near the fouling point. It is possible that the switch had been run through by a southbound train but the inspector seems to have been quite sure that the derailment did not occur until the engine reached the derailer.

New York Central, Harmon, N. Y., January 22, 1:40 a.m.—Collision in the passenger car yard, resulting in the death of one employee. The inspector finds the primary cause to have been the failure of a train crew to place empty coaches on the proper track; but the engineman of the moving train failed to keep his speed under control within yard limits.

Toledo, Peoria & Western, Smithfield, Ill., January 25.—Westbound mixed train No. 13, consisting of 13 freight cars and two coaches, drawn by locomotive No. 13, moving at from 20 to 30 miles an hour, was derailed, on a level straight line, and the whole train except the coach at the rear ran off the rails. The locomotive and most of the cars fell down a bank. The engineman was killed and two other employees were injured. The report contains an abstract, filling three pages, of the testimony of trainmen and officers of the road, going to show that the track was safe and that the derailment was unexplainable; but the inspector's conclusion is that the track was in poor condition and that this was the cause of the derailment.

The "Oregonian" Nearing Shasta Springs on the Southern Pacific's Line Between San Francisco and Portland

Van Sweringen Urges Early Decision

O. P. Van Sweringen gives testimony at hearing before I. C. C. on C. & O. application

WASHINGTON, D. C.

O. P. VAN SWERINGEN, chairman of the Chesapeake & Ohio, testified on June 7 and following days at the hearing before Director Mahaffie of the Interstate Commerce Commission's Bureau of Finance on the application of the C. & O., for authority to acquire stock control of the Erie and the Pere Marquette. He was offered as a witness at the request of counsel representing the protesting minority stockholders of the C. & O., and after a brief preliminary statement was turned over to them for questioning. H. W. Anderson, of counsel for the minority then began a series of detail questions concerning transactions of the various companies controlled by the Van Sweringen interests on a scale that indicated a protracted hearing, such as that which followed the original Nickel Plate unification application. The questions were devoted largely to showing the profits made and to be made by the Van Sweringen interests and to possibilities which might follow from the proposed acquisitions by the C. & O., while the Nickel Plate, although not included in the present plan, is under the same control.

At the outset Mr. Van Sweringen stressed the situation confronting the C. & O., because the option on Pere Marquette stock given to it by the Nickel Plate company expires on July 1. In view of its increase of about $5,000,000 in market value as compared with the price when it was optioned in December, 1926, he said that presumably it could not be renewed. To enable the commission to reach a determination of other issues in the case he offered to dispose of the Erie and Pere Marquette stocks held by himself and associates (as distinguished from the Nickel Plate company) to the C. & O., at actual cost, if the commission thinks that that should be done, instead of at the prices which were fixed by a special committee of C. & O. directors in response to his offer that they might "write the ticket" themselves.

"The time is short and already approaches that customarily required by this commission in which to render its decisions," he said. Continuing, he said: "apparently one element of this case which is being discussed is the price which the company should pay for the shares of Erie and Pere Marquette covered by the so-called Van Sweringen options. That price was fixed by a special committee without consultation with me. I believe it to be fair; it is nearly ten million dollars below its present market value. If, however, the committee had fixed the price at cost I would have accepted it. If the commission now thinks that I should sell the shares covered by the option at cost I will be equally content. My principal duty is as an officer of the C. & O. Railway and *its* interest with me is the dominant one. My personal interest is wholly subordinate.

"I understand the certified audit of the cost of these shares has been filed. This information was given to the board of the railway company and I have brought and hand you as a part of my testimony, the complete detail on that subject. With the information all in the record, I hope this commission, if it finds the proposed acquisition to be in the public interest, will find a way to pass on the other questions in time to allow the company to avail itself of the Nickel Plate option on the Pere Marquette shares, reserving if necessary for fuller consideration the price upon the so-called Van Sweringen shares. I will renew the Van Sweringen option as often as may be necessary. In other words, I do not want any question which is purely personal to me to delay the determination of other questions so that there will be any chance of the C. & O. losing the benefit of this Nickel Plate option."

Mr. Van Sweringen then put into the record a statement by Ernst & Ernst, accountants, showing the cost to the Vaness Company (the Van Sweringen personal holding company) of the Erie and Pere Marquette stocks held by it on September 30, 1926, the day following that on which the C. & O. directors approved the plan for the purchase of control of the two companies, including stock held by the Van Sweringen interests personally as well as by the Nickel Plate Company. This showed that 23,695 shares of Erie first preferred stock had cost $1,059,044; 22,305 shares of Erie second preferred $906,748; 345,239 shares of Erie common $11,122,873; and 36,500 shares of Pere Marquette common $2,386,316. The option prices to the C. & O. were $45.875 per share for Erie first preferred, $43.75 for second preferred, $34.50 for common, and $110 for Pere Marquette common.

The Nickel Plate option to the C. & O. fixes a price of $110 for 169,100 shares of Pere Marquette common and $639,162 as the cost to the Nickel Plate of 5,800 additional shares of Pere Marquette.

Mr. Anderson then asked for a detail statement of both purchases and sales of Erie and Pere Marquette stocks from the time of Mr. Van Sweringen's testimony in the Nickel Plate case to October 16, 1926, the date of the options. Herbert Fitzpatrick, general counsel of the C. & O. entered a vigorous objection to this, on the ground that information as to the cost of the stock proposed to be sold to the C. & O. was all that was relevant. Mr. Anderson insisted on his right to inquire into all the dealings of the witness in stocks which he proposed to sell to the company of which he is chairman; and Director Mahaffie overruled the objection, as well as many others later. Mr. Fitzpatrick noted an objection.

The witness was questioned at length regarding events preceding the adoption of the plan to buy Erie and Pere Marquette stocks in place of the plan for a unification including the Nickel Plate. Mr. Van Sweringen would not admit that he had dictated the plan or told the special committee what to do. He said he had left the matter largely to the committee and did not remember just who suggested the new plan. At one point in this discussion when Mr. Van Sweringen said that the original Nickel Plate case and this one are two separate things, Mr. Anderson retorted: "You testify as to the facts and we will argue later as to whether they are not the same." Mr. Van Sweringen declined to answer as to whether a block of 131,500 shares of Erie stock which he had told the committee could probably be purchased at the option price was owned by George F. Baker. He was asked to furnish also a statement of the cost to the

Nickel Plate of the Pere Marquette stock which it has optioned to the C. & O.

Mr. Anderson then took up the transactions by which the Nickel Plate sold its holdings of Pere Marquette and C. & O. stock in 1926 to the Special Investment Corporation, of which it owned the stock and which later transferred its C. & O. stock to the Chesapeake Corporation. Director Mahaffie asked how the holdings of the Investment Corporation in C. & O. could be reconciled with the promise made by the Nickel Plate company in 1923, when it was seeking authority for its directors to serve also as directors of the C. & O., that it would not acquire more than 20 per cent of the C. & O. stock without an application to the commission. Mr. Van Sweringen said he understood that after the interlocking directorship situation was changed by the resignation of the Nickel Plate directors from the C. & O., that covenant was dissolved. He was then asked to file any record indicating such action. The Chesapeake Corporation acquired 345,000 shares of C. & O. stock from the Investment Corporation and 255,000 shares from the Van Sweringen interests, while 1.7 shares of Chesapeake Corporation stock were distributed to the Nickel Plate stockholders for each share of Nickel Plate common held. After Mr. Van Sweringen had said that he and his associates and the Vaness Company still controlled the Nickel Plate and that the Vaness Company was still owned by the Van Sweringens and C. L. Bradley and J. R. Nutt, he was asked to file a statement showing the cost to the Vaness Company of the stock acquired to make up the 255,000 shares, in addition to the 174,800 shares held at the time of his former testimony.

Mr. Van Sweringen said he had participated to some extent in the arrangements for the Erie's recent $50,000,000 bond issue but was not familiar with the details. He said he knew of no physical obstacle to the diversion of traffic from the Erie and Pere Marquette to the Nickel Plate, which had been mentioned as a source of possible economies in operation at the hearing on the Nickel Plate application, but that he knew of no arrangements for doing so now that the Nickel Plate is not included in the proposed grouping. He said that if he had had his way it would be included.

A controversy similar to that during the Nickel Plate hearing was aroused when Mr. Anderson asked for a statement of all the loans made by the Van Sweringen interests, including their holding companies, from any of a list of ten "off-line" banks which he read, from an exhibit filed by an earlier witness at his request, in which the C. & O. had bank deposits. This included banks in New York, Cleveland and Detroit. After an argument Director Mahaffie overruled an objection by Mr. Fitzpatrick and Mr. Van Sweringen agreed to furnish the statement, but he vigorously denied the insinuation that he or any of his associates had used the credit of the railroad for their own purposes, saying that all of the loans were secured by abundant stock exchange collateral and could have been made anywhere.

Mr. Fitzpatrick based his objection on a former decision of the commission that the test is the fairness of the terms and conditions and the effect upon the assets of the carrier and its ability to serve the public, while Mr. Anderson cited the ruling of the commission in the Nickel Plate hearing that the Van Sweringens should be required to disclose their outside transactions. He also argued that a railroad officer can have no personal affairs touching the railroad and that the Van Sweringens had bought over 345,000 shares of stock, proposed to be sold to the C. & O., at a profit, after having made loans from banks in which C. & O. funds had been deposited instead of in banks in the territory from which the road derives its business.

Mr. Van Sweringen, after agreeing to furnish the statement, pointed out that deposits had been made in "on-line" banks as well and said that deposits in off-line banks are helpful to the business of the railroad also.

"I am extremely grieved that he should make the insinuation that we have, that I personally, or my brother or anybody associated with me, should have used the credit or influenced the credit in our direction personally because of those deposits," he said. "My brother and I have a considerable amount of property and collateral independent of this railroad. We owned other railroad properties before we owned the Chesapeake & Ohio, and we owned the Erie shares that are involved here, as the record clearly shows and as everybody knows, even this court must know, before there was any thought that the Chesapeake & Ohio would own the Erie, possibly.

"The Nickel Plate case is an evidence of that, and I have never, nor has anybody associated with us ever, used the credit of any of these railroads in furtherance of our own gains. In every instance where there have been borrowings, a tabulation of which is to be furnished pursuant to this request, the collateral has been New York Stock Exchange collateral in abundant quantity and the rates, as the loans will show, were above normal rather than below normal in those circumstances. Loans that could be made anywhere. With that statement I am glad to furnish the information."

The testimony of witnesses put on the stand by the C. & O., in the presentation of its case, was brought to a close, except as some of them had been asked to file additional information, on June 3, after many of the witnesses had been recalled for cross-examination a second or third time by counsel for the minority stockholders, whose requests for data brought the total number of exhibits filed up to that date to 100. Mr. Fitzpatrick then announced that he understood the minority counsel desired to have Mr. Van Sweringen appear and that he would be present on June 7.

The hearing on June 1, 2 and 3 was devoted to this cross-examination and re-cross-examination. W. J. Harahan, president of the C. & O., on June 3 testified that the options given the C. & O. by O. P. Van Sweringen to purchase the Erie stock held by himself and brother and associates at prices to be fixed by the C. & O. special committee, had expired but had been extended by Mr. Van Sweringen for 60 days to July 26.

The controversy as to the relevancy of matters pertaining to the proposed purchase of the stock of the Greenbrier & Eastern was renewed when Mr. Anderson questioned Mr. Harahan regarding details of the transactions and sought to put into the record a copy of Examiner Sullivan's proposed report containing criticisms of the C. & O. officers. Mr. Fitzpatrick objected on the ground that the Greenbrier case is before the commission in a separate proceeding, that exceptions have been filed to the report and that the commission has not yet decided whether it will follow the recommendations of the examiner. Mr. Anderson took the position that he had a right to question all the acts of the management of the C. & O., but Director Mahaffie sustained the objection.

The C. & O. witnesses were subjected to a most detailed questioning regarding items of their original testimony as to the economies to be expected from the proposed joint control of the three roads and similar matters and in many cases, where the witness said he had had clerical or other assistance in preparing the data presented, counsel for the minority insisted on having an opportunity to question the person who had prepared

the figures as well as many of the original notes, working papers and correspondence.

Referring to Mr. Harahan's testimony that the Erie line from Marion to Chicago could handle a 100 per cent increase in business and that it would be more economical to send coal to Chicago by that route than by the C. & O. Mr. Anderson asked if he had checked up his estimate of capacity from an engineering standpoint, as to such matters as capacity of bridges, etc., or whether he had merely gone over the line. Mr. Harahan said he built the line and knew what he was talking about.

On cross-examination Mr. Harahan said that he had sold his holding of 300 shares of common stock of the C. & O. last fall, before the plan for the purchase of Erie & Pere Marquette stocks had been adopted. He was asked to furnish the exact date later.

Mr. Anderson asked that the directors of the C. & O. who voted for the plan be called to testify why they did it. Mr. Fitzpatrick asked if he meant as witnesses for the protestants and when Mr. Anderson said he wanted the applicant to call them so that he might cross-examine them Mr. Fitzpatrick said that the applicant desired to use its own judgment as to what witnesses it should call.

He was also asked why the Virginia Transportation Company, which holds the C. & O. stock of Erie and Pere Marquette, had borrowed $2,800,000 from Morgan & Co. last December at 6 per cent when the C. & O. at the same time had over $12,000,000 on deposit in various banks, including Morgan & Co., at 2 to 3 per cent. He replied that this is a separate corporation that needed the money and that many of the C. & O. deposits were "tagged" for particular purposes as part of the working capital of the railroad.

Mr. Van Sweringen was excused to get up the statement called for and return next week, after which further cross-examination of some of the C. & O. witnesses was resumed.

Passenger Traffic Work As a Life Occupation

"DESPITE serious inroads by motor vehicles, the railroad passenger business is a good business today and always will be," according to M. M. Goodsill, general passenger agent of the Northern Pacific, in an address delivered at the annual banquet of the St. Paul Passenger Club at St. Paul, Minn., on January 17. "In the face of 10 unprecedented years of decreasing passenger earnings," he said, "a young man has to be either vocation-blind or a genuine optimist if he selected the passenger business for a life work. Many people are wondering and not a few are worrying about what is going to happen to the passenger business in America. The situation really requires less wondering and worrying and more thinking and acting. The northwest railroads are handling about half as many passengers as they were 10 years ago. There are 22,330,000 motor vehicles in the United States, including 80,000 motor buses. There are hundreds of air planes carrying thousands of passengers in Europe and a dozen or so planes carrying a few hundred passengers in the United States.

"Yet practically every man in this room, and most of us are young men, has chosen passenger transportation for his life work. There are only one or two things in the average man's biography of greater importance than choosing a life work. Why have young men here cast their lot with the passenger business? Are we blind to modern conditions and tendencies? Or are we in the game just because there's a job and a moderate living in it? It's a 'cinch' than none of us will ever be railroad presidents if we feel and think and work on any such basis. We'll get there only as we believe that the railroad passenger business is the very best profession in the world for us to undertake, and it's the most interesting.

Make a Wise Choice

"There have been plenty of moments of doubt and hesitation, but I am convinced that young men who deliberately and thoughtfully select railroad passenger work, are making a wise choice, and I believe the passenger business is a good business today and always will be. I can think of at least 10 reasons why.

"First, because passenger transportation is an essential industry. It has been so even centuries before the discovery of the wheel. Passenger transportation is necessary for American and world progress and civilization, and for individual happiness and education. Men in passenger service perform a real service to humanity and mankind.

"Second, because the railroad passenger business is difficult and therefore exceedingly interesting. Life is a dreadful bore to people who have it easy, with everything coming their way.

"Third, ours is a business of change, of variety of movement. There is no standing still. The railroads of America are just 100 years old. Think of the progress, the change within two generations!

"Fourth, the passenger profession is a friendly, friend-making business. Passenger men must represent the spirit of their companies and the success of both depends largely on the expression of that spirit, in daily contacts and service. Grouches, cynics, etc., are a complete failure in our 'line'—there is no place whatever for them.

"Fifth, the passenger business is a good profession for young men because there is so much competition in this field—and the competition is fair, though keen. The fast thinkers and workers win.

"Sixth, because associations in railroad passenger work are most pleasant. The business attracts men one likes to know.

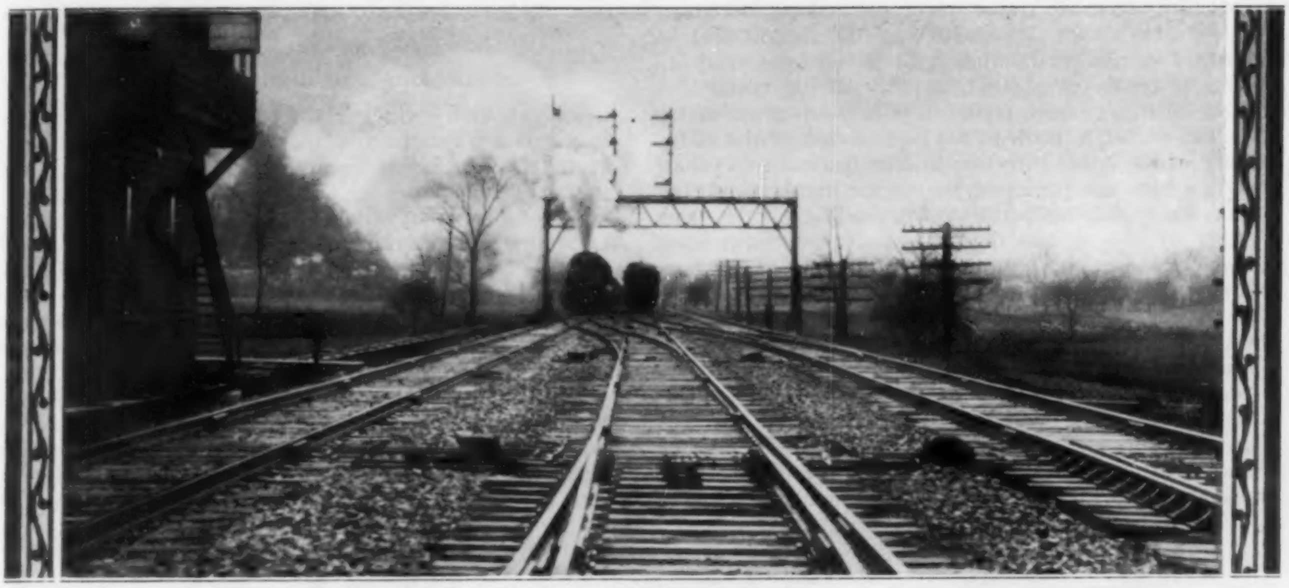
"Seventh, because travel is part of our work. Ours is a profession of wide understandings and practical education through travel and knowledge of both neighbors and far countries. An important part of our duty is to study the geography and interesting things about our own country, and others too, so that we will the better know how to sell travel.

Opportunity Is Great

"Eighth, passenger transportation presents a great opportunity for young men because there is so much to be done—methods of salesmanship to be improved and enlarged, standards of handling people to be raised, new things to be incorporated and adopted. Constant progress and action.

"Ninth, because promotions are fair and reasonably rapid and are won more often through merit and industry than in many other professions. Pay is not large, but very good compared with other industries. Returns are not fast, but they are sure.

"Tenth, the passenger business is one of broad scope —we have the world in general to sell, from a travel standpoint; and our own territory in particular. The work that we do covers wide range—train service, schedules, rates, excursions, plans, advertising, soliciting, securing and then serving passengers."



Eastbound Train on Track 1, and Westbound on Track 2, Passing Sleepy Creek

Three-Track Operation on B. & O.

Train movements directed by signal indication, using middle track in either direction, thus relieving serious congestion

THE practicability of directing train movements by signal indication on three tracks, with movements in either direction on the middle track has been demonstrated by the Baltimore & Ohio for nine years on 25 miles of line between Miller, W. Va., and Orleans Road. The B. & O. lines from St. Louis and Chicago join at Cumberland, Md., a short distance west of Orleans Road, while eastbound traffic begins to diverge at Cherry Run, W. Va., just east of Miller. Therefore, this part of the division between Orleans Road and Miller is the neck of the bottle, and prior to 1915 it, then double-track, was the most congested section on the road. To relieve this situation, a four-track line was contemplated between these points, but it was decided first to extend the passing tracks to complete a third track. At the same time automatic signals were provided for normal direction operation on the outside tracks and interlocking plants were rebuilt to handle all crossovers. Controlled manual block signaling with traffic-direction locking was arranged for directing train movements in either direction on the center track. As additional tracks were required at the coaling and water station at Sir John's Run, a fourth track was provided for 5.6 miles between Hancock and Sir John's Run interlocking, between which points the No. 2 track is signaled in both directions and the No. 3 track is signaled for westbound movements only. This arrangement has proved very effective and, in spite of the fact that the volume of traffic has increased considerably during the last ten years, adequate capacity is available for a still further increase.

Volume of Traffic Being Handled

The preponderance of tonnage in this territory is eastbound on account of the heavy coal movement. For example, in the week ending December 10, 1926, the east bound freight traffic included 217 eastbound trains with 5,036 cars of Q.D. (quick despatch) freight, 12,717 cars of coal, 927 cars of other freight and 149 empties, and the westbound traffic consisted of 197 trains with 2,010 cars of Q.D., 16,161 empties and 1,169 other freight. An eastbound train handles an average of about 8,000 tons, with about 90 cars. Westbound trains handle the limiting number of empties, which is 125 cars, totaling about 3,350 tons. The maximum eastbound movement in one day was 3,365 cars but the track facilities are adequate for a considerable increase over this.

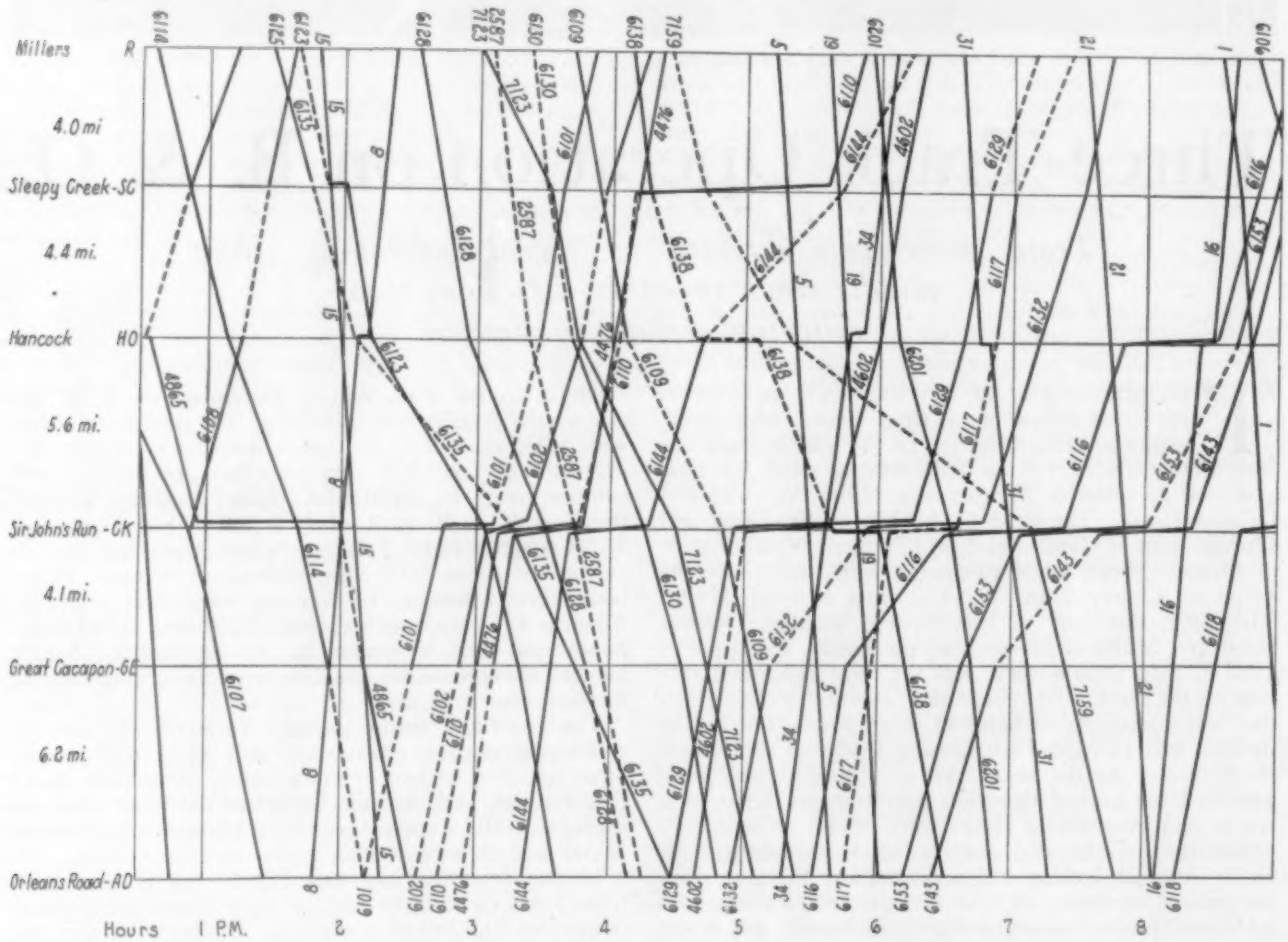
The passenger traffic includes 14 eastbound and 13 westbound regular trains daily and extra sections are often operated on two or more trains. The table shows that for the week ending December 10 there were an average of 102.2 trains daily over the territory between Miller and Orleans Road.

In this territory 100- and 130-lb. rail is used with treated ties on stone ballast, all three tracks being maintained for high-speed operation. Ordinarily trains are operated in the normal direction on the outside tracks, but whenever it is necessary to run a passenger or a fast freight train around a tonnage freight, the slower train is diverted to the center track and the faster train holds the outside main. The dispatcher figures out his moves in advance. An annunciator in each tower rings when an approaching train arrives at a point about two miles from any interlocking, at which time the leverman informs the dispatcher. The latter then instructs the leverman whether to allow the train to go through or to divert it to another track, as will be described later.

In order to show how the trains are routed on this three-track territory a chart was drawn showing the

manner in which the trains were operated on December 20, 1926, on which day there were 37 freight and 14 passenger trains eastbound, and 36 freight and 17 passenger trains westbound, a total of 104 trains. A section of this graphic train sheet between noon and 8 p.m. was chosen to show to the best advantage the added facility of the either-direction middle track. In this chart freight trains are indicated by engine numbers of four digits while passenger trains are marked by the train number of one or two digits. Eastbound trains leave Orleans Road at the bottom and westbound trains have Miller at the top of the sheet. Trains running on the two outside normal direction tracks are shown by full lines while trains diverted to the middle track are shown dotted and trains running on the fourth track between Hancock and Sir John's Run are shown by long dash lines.

For example, eastbound freight No. 4476 leaving Hancock at 4:02 p.m. was operated on the outside main track, No. 1, while freight No. 6110, leaving Hancock at 4:03 p.m., was operated on the middle track, running around No. 4476, and arriving at Sleepy Creek at 4:10 p.m., two minutes ahead of No. 4476. Both of these trains passed No. 6109, a westbound freight train running on the normal direction westbound track No. 3. Again, westbound freight No. 6135 arrived at Sleepy Creek at 1:47 p.m., where it was diverted to the middle track to permit passenger train No. 15, passing Sleepy Creek at 1:53 p.m., to operate on the outside track, running around No. 6135 between Sleepy Creek and Hancock. Many other run around movements are shown in this chart.



Graphic Train Sheet for Period from Noon to 8 p. m., December 20, 1926

Interlocking and Signal Equipment

Between and including the points named, interlocking plants are located at Miller, Sleepy Creek, Hancock, Sir John's Run, Great Cacapon and Orleans Road. The interlocking machines are of electro-mechanical type. All slow-speed signals, switches and facing point locks are operated by the mechanical levers, while all high-speed and restricted-speed signals, detector locking, traffic direction control between towers, and electric locks on outlet switches at passing sidings are controlled by the electric levers which are mounted above the mechanical levers.

The full stroke of the electric levers operates the power signals from 0 to 45 deg. A push button, in addition to the lever, controls the 90 deg. position of the signal. Each lever is electrically locked, preventing it from being placed in its normal position if the signal fails to return to the stop position. The detector lock levers are arranged to be electrically locked in the reverse position when the track sections controlling them are occupied. With the application of the electro-mechanical machine, it is possible to place double the number of levers in the space required for the ordinary mechanical machine, and consequently, the size of the tower is reduced to a minimum. The switches are so arranged at each interlocker that parallel movements to and from the center track can be made simultaneously.

Controlled Manual Block System

The center track between Miller and Hancock and also between Sir John's Run and Orleans Road, as well as the eastbound freight track between Hancock and Sir John's Run, are operated under the controlled-manual block system In these sections traffic may be moved in either direction by signal indication, without the issuance of orders, much time being saved by the elimination of the latter.

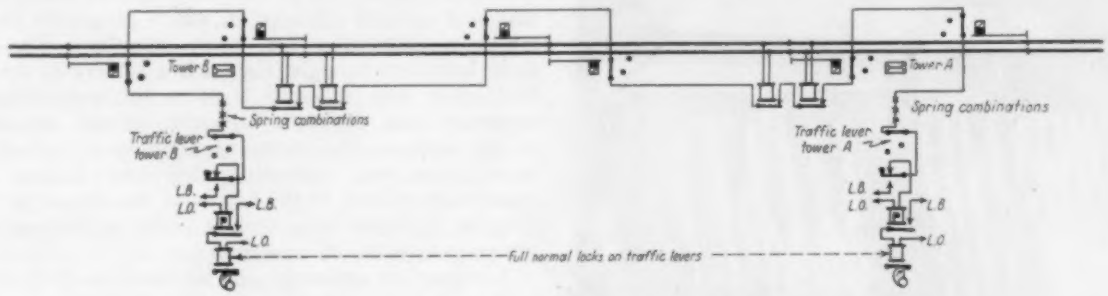
The term "controlled manual block" infers that there is continuous track circuit throughout, and that the signals governing movements therein are controlled by the track circuit and are also under the control of a signalman. The principle on which the controlled-manual block system is based is that, before a signal can be changed to indicate "proceed" to admit a train into a block, the co-operation of two operators, one located at each end of the block, is necessary. The traffic levers are electrically locked in the normal position and when necessary are released by battery from the other tower.

Traffic direction control is effected by traffic levers in each machine. Therefore, to move traffic, for example, eastbound from Hancock to Sleepy Creek, the traffic lever in the machine at Sleepy Creek must be normal, and the traffic lever in the machine at Hancock must be reversed before any signals governing to the center track at Hancock can be changed to indicate "proceed" and vice-versa for westbound movements from Sleepy Creek when moving traffic over this same track from that point to Hancock. The reversal of a traffic lever also electrically locks the traffic-lever normal in the machine at the other end. After a train accepts a home signal indication and moves into the block on the center track, it is impossible to manipulate the traffic lever at the next tower to clear any opposing signals leading to that track. For following train movements on the middle track no co-operative action is required other than the regular reporting of trains, it being only necessary that the leverman clear the entering signal. Approach signals are provided for all interlocking home signals, but no intermediate automatic signals are used on the center track.

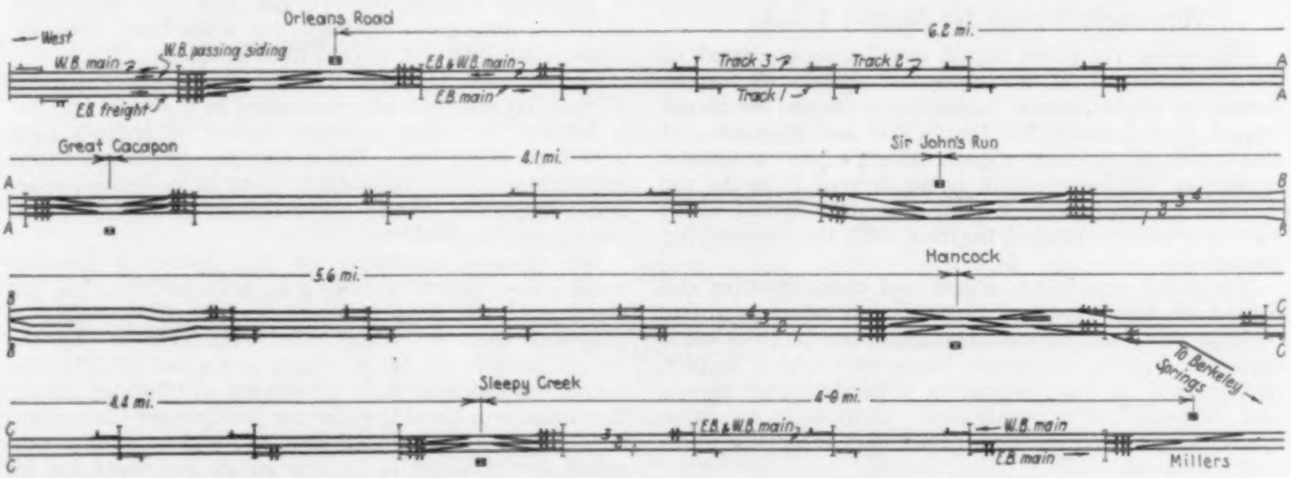
Special Traffic Locking Circuit

Typical circuits for the traffic levers are shown in the diagram, one wire being used for directional control of both eastward and westward movements. The circuit requires that (a) all track circuit section between home interlocked signals must be unoccupied; (b) all home and intermediate signals governing movements in each direction over the track governed must indicate stop; and (c) simultaneous operation on the part of operators in adjacent towers—one to give the "unlock," the other to obtain release. The circuits may be traced as follows

To run a train from tower "A" to tower "B," with traffic levers normal, the operator at tower "B" presses the push button, opening his control relay, giving battery LB, through the traffic lever at tower "B," through the spring combinations in the machine (used for selecting through the various track circuits according to the layout of switches), through the circuit breakers on the signals (all of which are closed only when the signal indicates stop), through the contact points on intermediate track relays, through the spring combinations and selective relays at tower "A," the traffic lever at tower "A" normal, the push button at tower "A" normal to coils of the indicating relay and finally to common. This latter relay, when energized, gives battery locally, to unlock the traffic lever. Operation in the reverse di-



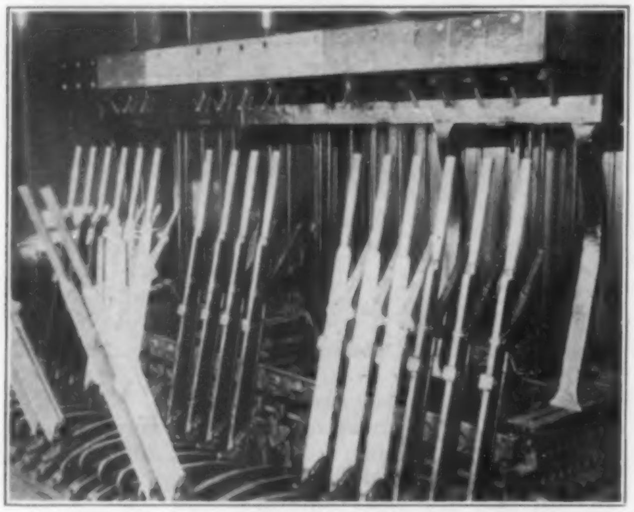
Typical Circuit for Traffic Direction Locking Between Towers



Track and Signal Plan from Miller to Orleans Road, Center Track Operated in Either Direction

rection is identical. All line circuits between towers are carried in an insulated aerial cable and no incorrect operation of circuits has been occasioned by shorts, grounds or opens in this cable.

In addition to the Morse telegraph, quick means of intercommunication is provided through the application of bells and telephones, the circuits being used in combination. By depressing a floor push the telephone can be used, while when the floor push is normal the bells can be used, being controlled by a push button. Normally the bells are in circuit and are operative through the depression of an ordinary key. When it is desired to use the telephone, indication is given by the bell code, and the floor push is depressed, which puts the telephone in circuit and switches the bells out. Only one wire is used for this purpose.



An Electro-Mechanical Interlocking Machine

Automatic Signals for Normal Tracks

The entire automatic signal installation consisted of the application of 32 new automatic signals, 29 for the protection of the outside tracks and 3 for the eastbound freight track between Sir John's Run and Hancock. It also made 67 existing signals effective for automatic protection, full benefits now being derived from the use of these 67 three-position semi-automatic signals which were previously installed together with the interlocking plants.

The signal aspects are simple and comprehensive and consist of four types of signals, viz: one-arm three-position automatic signals; two-arm three-position semi-automatic signals; three-arm home interlocking signals, having two- and three-position semi-automatic signals and two-position non-automatic permissive or slow-speed signals; and one-arm dwarf non-automatic interlocking signals.

Under the manual block system five block sections were used between Miller and Orleans Road, whereas the application of automatic block signals provides 23 block sections. Under the present improved method of operating the center track, greater facility is attained by reason of the fact that the movement of trains is conducted entirely by signal indication. It may be necessary later to apply automatic signals for both directions on the center track at intervals similar to those existing on the outside tracks in order to facilitate following movements over the middle track, although the need for them is not felt at this time.

Meeting of Operating Division

THE operating division of the American Railway Association held a special meeting in New York City on June 6, with an attendance of about 60 representatives. J. J. Pelley, president of the Central of Georgia and chairman of the division, presided, and J. C. Caviston, secretary of the division, was secretary of the meeting.

The principal business was the discussion of a report from the committee on operation, H. E. Hutchens (So.) chairman, presenting numerous proposed changes in the standard code of train rules, which proposals have been under consideration for many months. The discussion, however, brought out such a variety of views that the report was referred back to the committee. The secretary was directed, however, to call the attention of all roads to the questions pending in regard to the train rules and requesting that any further desired changes be placed in the hands of the secretary prior to August 1, next; this with a view to having another meeting as soon as practicable.

A report on utilization of locomotives, prepared by a joint committee of the operating division and the mechanical division (T. B. Hamilton, vice-president of the Pennsylvania, chairman) was presented by Mr. Hamilton. This report is based on studies and field surveys made on 13 prominent roads, covering a wide range of territory; and it is accompanied by voluminous tables containing summaries of the information which has been gathered concerning locomotive performance. The body of the report is made up mainly of facts concerning the increased use made of locomotives in the last few years and arguments supporting the various changes in practice that the committee has observed.

Of 149 Class I railroads, the records of which have been studied, it appears that 96 have increased the average mileage of freight locomotives in 1926 as compared with 1925 and 82 roads have increased the average miles of passenger locomotives. At the same time, the speeds of trains and gross tonnage per train have been increased, but quantity of coal used lessened.

The increase of locomotive mileage by the extension of runs has not been as pronounced as it should be; this is because too many different classes of engines have been kept in service. The committee makes numerous suggestions for further improvement in locomotive practice. Executive officers are urged to give personal attention to this problem.

The general committee of the Operating Division made a brief report reviewing its activities since the last meeting of the division which was in May, 1925. A proposed code of safety rules recommended by the Safety Section, A. R. A. which was considered by this committee and was made the subject of inquiries among the roads, was decided to be too voluminous for general adoption as recommended practice, and it is now proposed that these rules be sent to all the roads for information and for such use as may be practicable in preparing safety rules adapted to local conditions. The committee also rejects a proposal to have a standard A. R. A. specification for watches and clocks. Rule No. 2 is deemed sufficient.

The general committee of the operating division consists of J. J. Pelley, (C. of Ga.); E. C. Denney, (N. Y., C. & St. L.); P. R. Albright, (A. C. L.); E. P. Bracken, (C. B. & Q.); E. E. Calvin, (U. P.); C. W. Galloway, (B. & O.); S. J. Hungerford, (Can. Nat'l.); F. Walters, (C. & N. W.); A. G. Wells, (A. T. & S. F.) and E. T. Whiter, (Pa.).

Purchases of Supplies and Equipment Larger in 1926

Increased buying shown in all classes of material—Expenditures for locomotives nearly double

THE expenditures of the Class I railroads, not only for material and supplies but also for equipment, were considerably larger in 1926 than in 1925, except in the case of freight cars, according to compilations recently completed by the Bureau of Railway Economics of the American Railway Association. The expenditures for supplies, excluding materials supplied by contractors of engineering projects, etc., amounted to approximately $1,559,000,000, while the total equipment expenditure amounted to $371,922,000.

The reference to the expenditures for material and supplies made by W. G. Besler, chairman, Central of New Jersey, in an address before the annual convention of Division VI—Purchases and Stores—A. R. A., and published in the May 28 issue of the *Railway Age*, page 1599, may now be supplemented with more detailed figures issued by the Bureau on May 26. In its compilation the Bureau finds that while the expenditures for materials and supplies were 10.4 per cent less than in 1923, they were 12 per cent greater than in 1925 and 16.1 per cent greater than in 1924. The details and expenditures are given in Table I, which shows expenditures of approximately $473,000,000 by the Class I railroads for fuel in 1926, including approximately $367,000,000 for bituminous coal and $90,000,000 for fuel oil, while expenditures for forest products amounted to approximately $186,000,000 including $101,000,000 for cross ties and $62,000,000 for timber and lumber. The total bill for iron and steel products amounted to approximately $507,000,000, comprised of approximately $110,000,000 for steel rails, $61,000,000 for wheels, axles and tires, $83,000,000 for frogs, switches and other track work, $67,000,000 for structural steel, bar iron, forgings, pressed steel parts, etc., and $174,000,000 for miscellaneous iron and steel products. The bill for miscellaneous materials amounted to approximately $392,000,000, including $6,976,000 for cement, approximately $27,000,000 for lubricants and illuminating oil, $29,000,000 for air brake materials and special appliances for locomotives, $28,000,000 for electrical materials, $28,000.000 for stationery and printing, and $185,000,000 for such purchases as track shovels, brooms, bolts, rivets, chemicals for wood preservation, etc.

Table I—Purchases by Class I Roads in 1926

Fuel:	
Bituminous coal	$367,843,258
Anthracite coal	8,138,156
Fuel oil	90,236,161
All other	7,136,353
Total fuel	$473,353,928
Forest Products:	
Cross ties (treated and untreated)	101,174,559
Switch and bridge ties (treated and untreated)	13,791,978
Timber and lumber	62,117,799
Other forest products	9,206,898
Total forest products	$186,291,234
Iron and Steel Products:	
Steel rail (new and second hand, except scrap)	110,647,592
Wheels, axles and tires	61,421,089
Frogs, switches, crossings, track fastenings and bolts, spikes, tie plates, rail anchors, etc	83,901,021
Iron bridges, turn tables, structural steel, bar iron, and steel forgings, fabricated and unfabricated shapes and pressed steel parts	66,939,790
Flues and tubes for locomotives and stationary boilers	10,240,873
Other iron and steel products	174,151,821
Total iron and steel products	$507,302,186
Miscellaneous:	
Building cement	6,976,684
Lubricating oils and grease; illuminating oils; boiler compound; waste	26,995,545
Metal and metal products	61,058,782
Ballast	25,718,172
Air brake material, standard and spec. appliances for locomotives	29,615,778
All electrical materials	28,158,285
Stationery and printing	28,418,710
Other miscellaneous purchases	185,143,027
Total miscellaneous	$392,084,983
Grand total	$1,559,032,331

Note—Values include freight and handling charges.

Table II—Purchases by Class I Roads, 1923-1926

Item	1923	1924	1925	1926
Fuel	$617,800,000	$471,656,000	$459,465,341	$473,353,928
Forest products	232,511,000	180,872,000	170,305,031	186,291,234
Iron and steel products	464,955,000	365,610,000	419,254,603	507,302,186
Miscellaneous	423,437,000	324,917,000	343,018,479	392.084,983
Grand total	$1,738,703,000	$1,343,055,000	$1,392,043,454	$1,559,032,331

In Table II, the total expenditures for fuel, forest products, iron and steel products and miscellaneous materials are compared with corresponding expenditures in previous years. The expenditures in each of the four large groups of items are shown to have increased in 1926 as compared with 1925 and except for forest products, the purchases in 1926 were larger in all cases than in 1924.

Estimates of the quantities of materials and supplies purchased are given in Table III. Approximately 140,000,000 net tons of bituminous coal were purchased in 1926, and over 3,000,000,000 gal. of fuel oil. This is a larger volume of bituminous coal than in any year since 1923, and a record purchase of fuel oil. The bituminous coal purchases by the railroads represent approximately 25 per cent of the total production in the United States, while railroads consume about 4½ per cent of the anthracite coal and 20 per cent of the fuel oil.

Table III—Quantities of Supplies Purchased by Class I Roads

Fuel:	1923	1924	1925	1926
Bituminous coal—net tons	154,902,000	126,372,000	129,325,480	140,083,885
Anthracite coal—net tons	5,016,000	4,673,000	3,780,113	3,677,505
Fuel oil—gals	2,962,619,000	2,848,550,000	3,043,783,152	3,058,915,511
Forest Products:				
Cross ties—units	113,907,000	98,130,000	87,964.517	93,759,913
Switch and bridge ties—Bd. ft.	2,388,785,000 (with timber and lumber)	329,040,000	306,444,000	365,956,555
Timber and lumber—Bd. ft.		1,296,430,000	1,416,111,000	1,580,766,701
Iron and Steel Products:				
Steel rail—gross tons	1,888,600	1,778,750	2,179,201	2,503,991
Miscellaneous:				
Cement—bbl.	2,416,000	2,210,800	2,104,206	3,126,500
Ballast—cu. yds.	....	14,265,000	21,672,754	25,421,831

The number of cross ties purchased in 1926 amounted to $93,759,913 while 1,580,766,701 bd. ft. of timber and

lumber, excluding switch ties, was involved in the expenditures. These quantities represented increases in both cases over the quantities purchased in 1925. In connection with steel rails, of which 2,503,991 gross tons were purchased in 1926, or considerably more than any of the four previous years, it is observed that for the first time since comparative figures have been compiled the railways spent more money for iron and steel products than for fuel.

It is estimated that the railways purchased about 15 per cent of the total timber cut of 1926, which would be increased to about 25 per cent if lumber acquired indirectly in connection with construction work were included. The consumption of steel by the railways represents about 25 per cent of the total steel output of the United States and the purchases of rails represent about one-fifth of the total steel purchases by the railways.

Table IV—Capital Expenditures Class I Roads, 1923-1926

Equipment	1923	1924	1925	1926
Locomotives	$208,966,280	$102,456,404	$59,777,575	$108,263,000
Freight train cars..	409,664,895	318,570,882	222,476,281	185,792,000
Passenger train cars.	40,105,358	53,133,583	41,207,044	58,117,000
Other equipment....	22,987,458	19,447,591	14,653,496	19,750,000
Total—Equipment.	$681,723,991	$493,608,460	$338,114,396	$371,922,000
Roadway and Structures:				
Additional track (a).	108,745,245	116,725,143	145,756,793	166,758,000
Heavier rail	27,865,942	32,037,372	32,951,877	42,184,000
Additional ballast ..	9,471,311	10,824,944	11,665,362	16,520,000
Shop and engine houses (b)........	51,214,185	39,833,581	31,345,249	46,882,000
All other improvements	180,128,752	181,713,728	188,357,585	240,820,000
Total—Roadway and structures..	$377,425,435	$381,134,768	$410,076,866	$513,164,000
Grand total......	$1,059,149,426	$874,743,228	$748,191,262	$885,086,000
Ratio R & S to total	36%	43%	55%	58%

(a) Includes rail and tie fastenings and other track material.
(b) Includes machinery and tools.
No allowance made for retirements in any of these statistics.

More Money for Locomotives

The total capital expenditures for equipment on Class I railroads last year amounted to $371,922,000, which was an increase over the expenditures for 1925 but was still considerably less than the total expenditures in 1924 and 1923. The details are given in Table IV, which shows the capital expenditures for improvements to roadway and structures as well as for equipment. In 1926 the expenditures for freight cars only, amounted to $185,792,000 as compared with $222,476,281 in 1925 and still larger amounts in 1924 and 1923. In contrast with the expenditures for freight cars, the investment in locomotives, amounting to $108,263,000 in 1926, was larger than any year since 1923 and represents an increase of over 80 per cent over the expenditure in 1925. The expenditures of $58,117,000 for passenger cars and $19,750,000 for other equipment were also increases over the corresponding figures registered in the previous year.

The expenditures for improvements to roadway and structures amounted to $513,164,000 in 1926, which are considerably larger than in any of the four years previous and represent a steadily increasing investment, the expenditures for additional track, heavy rail, additional ballast, shops and enginehouses and all other improvements being larger in every case than in the previous year, and exceeding those for any of the four years excepting in the case of the expenditures for shops and enginehouses, which were slightly greater in 1923 than in 1926.

The table shows a steady increase in expenditures for roadway and structures in both amount and percentage. In 1923, when the railways spent $377,425,435 for improvements to roadway and structures (including labor and material), the percentage of this expenditure to the total capital investment was 36 per cent. As compared to this, the percentage was 43 per cent in 1924; 55 per cent in 1925; and 58 per cent in 1926. With an increase in the expenditures for equipment from $338,114,396 in 1925 to $371,922,000 in 1926, it is apparent that the increase in the percentage of roadway and structures improvements to the total investment was not the result, in this instance, of a decrease in the expenditures for equipment.

I. C. Advocates Growing of Soy Beans as Substitute for Corn

THE raising of soy beans as a means of overcoming the excessive production of corn and other crops and thereby make farming more profitable, was advocated by the Illinois Central on a soil and soy bean special train operated on its lines in Illinois from March 28 to April 16, in co-operation with the University of Illinois, the A. E. Staley Manufacturing Company, Decatur, Ill., and Funk Bros., Bloomington, Ill., under the supervision of H. J. Schwietert, general development agent of the railroad. The six-car train, which made 106 stops that drew a total attendance of 33 939 people, carried exhibits showing the advantages of raising these beans. A total of 34 by-products and 30 varieties of the bean were displayed. In addition, the train carried exhibits on soil and the European corn borer.

Several Varieties of Soy Beans Were Placed on Display on the Train

The soil exhibit car was prepared under the direction of the College of Agriculture of the University of Illinois and contained a soil laboratory where samples of soil were tested for farmers. In addition, instruction was given in the methods of soil treatment and a soy bean exhibit showed the varieties of soy beans and the method of planting. Exhibits also showed the damage being done to the corn crop by the European corn borer and showed how to control this pest.

Unfavorable Report on N. Y. C. Unification Plan

WASHINGTON, D. C.

DENIAL of the applications filed with the Interstate Commerce Commission for authority for a further unification of the New York Central system by 99-year leases of the Cleveland, Cincinnati, Chicago St. Louis and subsidiaries and of the Michigan Central and Chicago, Kalamazoo & Saginaw is recommended in a proposed report by Examiner Ralph R. Molster made public by the commission on June 2.

Denial is recommended on the sole ground that definite provision has not been made for including in the proposed unification appropriate connecting short lines, and, in view of the conclusions recommended on this point, consideration of the terms and conditions of the proposed leases and other issues is declared to be unnecessary.

The examiner quotes from the commission's decision of last year in the Nickel Plate case that "every applicant should assume the burden of making reasonable provision in its plan for the possible incorporation of every connecting short line" in operation in the territory involved, and he refers to the union of weak with strong lines as the primary object sought to be accomplished by Congress in permitting combinations of railroad properties. He also refers to the declaration in the Virginian case that applications for authority to acquire control of railroads "must be supported by a clear and strong showing of public gain"; and says that considerations as to the advantages to be expected from unified operation "still are subsidiary to the major purpose of the transportation act, which is to preserve 'substantially the whole transportation system,' and not merely to bring about improvement in service already performed with a creditable degree of efficiency."

If the matter of including the independent short lines is deferred to the time when complete consolidation may be proposed, says the report, it may be indefinitely deferred, and therefore the present applications should be denied as not being in the public interest, because "approval of the leases would complete unification of the New York Central Lines without the assumption of obligations which Congress intended should be assumed in consideration of its permission to do hitherto forbidden things."

Purpose of Proposals

The New York Central, the Big Four, and the Michigan Central are operated as separate units, but under common control. The following is a recapitulation of testimony as to operated main-line mileage involved in the unification proposed:

Owned and leased lines:	Miles of road
New York Central	6,376.89
Big four	2,220.85
Michigan Central	1,762.30
Kalamazoo	55.35
Cincinnati Northern	205.14
Terre Haute	139.77
Total	10,760.30
Lines operated under trackage rights	747.51
Grand total	11,507.81

Prior to June 27, 1922, the New York Central owned $30,207,700, or approximately 64 per cent, of the common stock of the Big Four but did not own any of the preferred stock. On that date the commission authorized acquirement of further control by the purchase of additional stock, common and preferred. It was conceded in the record that officers of the New York Central had in mind that if two-thirds of the stock were acquired, a lease of the Big Four properties might be consummated without persuading minority stockholders that it was to their advantage.

Carrier companies involved in the proposal of the New York Central are now controlled, directly or indirectly, by that company as indicated in the following tabulation of stock ownership:

Company	Par value outstanding*	Owned by N. Y. C. or a subsidiary		Owned by minority interests	
		Par value	Per cent	Par value	Per cent
Big Four:					
Common stock	$47,028,700	$42,941,100	91.31	$4,087,600	8.69
Preferred stock	9,998,500	8,468,100	84.69	1,530,400	15.31
Michigan Central	18,736,400	18,577,900	99.15	158,500	0.85
Kalamazoo	450,000	180,000 †270,000	100.00	....	....
Cincinnati Northern	3,000,000	‡2,931,600	97.72	68,400	2.28
Terre Haute	4,290,000	‡4,290,000	100.00	....	....

*All shares of the par value of $100.
†Owned by the Michigan Central.
‡Owned by the Big Four.

Common executives serve both the New York Central and the subsidiary companies. Thirteen of the 15 directors serving the Big Four and the Michigan Central also serve the New York Central in similar capacities.

The following table affords a comparison of dividends paid on Michigan Central stock and Big Four common stock, with net earnings of those companies in the years 1921 to 1925:

	Mich. C.	Big Four
Aggregate net income	$76,681,105	$41,564,597
Less, dividends on preferred stock	....	2,499,625
	$76,681,105	$39,064,972
Dividends paid	16,394,350	*9,170,596
Ratio of dividends to net income available (per cent)	21.38	23.47

*On common stock.

Transactions

In 1926 nearly 7,000 shares of Michigan Central stock were purchased by the N. Y. C. at $1,000 per share. Offers made to Big Four stockholders from time to time had been largely accepted, but ideas of minority stockholders as to appropriate rentals under the proposed leases were neither sought nor obtained, except as opportunity for expressing their views may have been accorded the minority at stockholders' meetings called for the purpose of passing upon prior action by the boards of directors.

Execution of the leases was authorized June 9, 1926, subject to the consent of the holders of two-thirds of the capital stock of the respective companies. In September, 1926, the consent of the stockholders was given in all cases except that of the proposed lease from the Big Four to the New York Central, voting upon that proposal having been restrained by the United States district court at Cincinnati.

Proposed rentals are:

On Big Four stock—	Per cent
Preferred	5
Common	10
On Michigan Central stock	50
Cincinnati Northern stock	12
Kalamazoo	6
Terre Haute stock	4

The extent of the obligation ultimately to be assumed by the New York Central is limited to minority hold-

ings. Minority stockholders were accorded the option of accepting such rentals or selling their stock to the lessee at fair values to be determined by agreement or by arbitration.

It is expected to maintain existing routes and to comply with routes designated by shippers, but it is hoped ultimately to have freedom of operation as to the routing of freight and thereby promote better and more economical service.

Part of the report is devoted to the arguments urged at the hearing for and against the terms of the leases in relation to the interest of the minority stockholders who intervened in opposition, insisting that the rentals proposed are too low in view of the average net earnings per share in the five-year period 1922-1926 of $20.37 on Big Four common and $84.74 on Michigan Central.

The intervening short lines are the Ulster & Delaware, the Fonda, Johnstown & Gloversville, the Federal Valley, the Chicago, Attica & Southern and the Southern New York, which asked that the application be denied except on provision for their inclusion in the unified system.

Following the description of the proposed plan and a review of the evidence the report discusses the issues in part as follows:

Question as to Public Interest

The applicants contend that control, as proposed, would be in the public interest, because of advantages expected and because of the absence of objection to the leases from the standpoint of the public interest. On behalf of the short lines it is replied that the applicants made no material showing of public gain to result from their proposals. Consolidation was the real aim of Congress. The New York Central system would be so thoroughly integrated that little incentive would remain for the taking of further steps later. The applicants, however, contend that this is not an appropriate occasion for considering the inclusion of any so-called short-line railroads. When appropriate occasion arises for the consideration of these questions, they will be approached by the New York Central in a spirit of co-operation. But, the short lines reply, the distinction is one of degree and not of principle. With respect to values, the applicants point out that there has been no final valuation of the properties, and contend that the figures in the protests should not be used to test reasonableness of the rentals; further, that the provisions of section 15a afford no assurance as to the return which will be realized by the properties. In long-term commitments, they assert, consideration should not be confined to current conditions in total disregard of uncertainties of the future, and the use of recent net income as the basis of the computations is considered to be very favorable to the minority. Concerning the provisions of certain Ohio statutes, the applicants point to paragraph 8 of section 5, providing for relief from the operation of anti-trust laws and all other restraints or prohibitions by law, state or federal, in so far as may be necessary to enable carriers to do anything authorized by any order made by the commission under and pursuant to preceding provisions of section 5, and cite cases in which the commission has held that state statutes were inapplicable. In reply to objections of the minority to other provisions of the proposed leases, the applicants direct attention to the New York Central's willingness, expressed at the hearing, that language with respect to which the minority entertain doubt or apprehension be altered or amended to the satisfaction of the minority.

Conclusions

. . . The Supreme Court of the United States has heretofore had occasion to comment on the general object sought to be attained by the transportation act. In the New England Divisions case the court said, "The 1920 Act sought to ensure . . . adequate transportation service. The new purpose was expressed in unequivocal language. . . To preserve for the nation substantially the whole transportation system was deemed important." And this broad view was subsequently reiterated in the statement that "the new act seeks affirmatively to build up a system of railways prepared to handle promptly all the interstate traffic of the country." Short-line railroads, as well as trunk lines, are parts of the railway net whereby the people of the United States obtain transportation by railroad. The short-line carrier performs service which is important to the people in otherwise isolated regions. In *Nickel Plate Unification*, the commission gave notice that every applicant should assume the burden of making reasonable provision in its plan for the possible incorporation of every connecting short line now in operation in the territory covered. Therefore . . . it must be shown that proper consideration has been given to the primary object sought to be accomplished by Congress in permitting combinations. The applicants' claim of exoneration from compliance with this rule is without merit. Nor is there merit in the applicants' contention that no objection, from the standpoint of public interest, has been presented by state authorities or shippers. This contention overlooks the protest of the governor of Ohio and disregards representations made in this proceeding on behalf of the Ohio interests and the short lines. . . . As the record stands consideration of the matter of including appropriate short lines may be indefinitely deferred. This serious doubt as to the wisdom of the proposed grouping must be resolved against the applications. It is therefore recommended that the commission find that the applications should be denied.

Freight Car Loading

WASHINGTON, D. C.

REVENUE freight car loading in the week ended May 28 amounted to 1,026,397 cars, a decrease 54,389 cars as compared with the corresponding week of last year, although an increase of 113,310 cars as compared with 1925. Decreases were shown in all commodity classifications as compared with last year, and increases as compared with 1925. The principal decreases were in the loading of coal and miscellaneous freight. All districts except the Pocahontas also showed decreases as compared with last year. The summary, as compiled by the Car Service Division of the American Railway Association follows:

Revenue Freight Car Loading Week Ended Saturday, May 28, 1927

Districts	1927	1926	1925
Eastern	236,805	261,684	210,596
Allegheny	212,959	218,814	184,206
Pocahontas	62,891	57,816	49,723
Southern	152,231	155,360	139,724
Northwestern	156,283	165,894	140,964
Central Western	133,810	144,572	122,007
Southwestern	71,418	76,646	65,867
Total Western dists.	361,511	387,112	328,838
Total all roads	1,026,397	1,080,786	913,087
Commodities			
Grain and grain products	39,604	44,189	36,815
Live stock	28,336	28,640	24,897
Coal	155,723	177,598	149,604
Coke	10,497	11,776	9,184
Forest products	71,860	79,380	70,785
Ore	62,201	66,499	59,690
Mdse. L.C.L.	261,699	266,304	229,083
Miscellaneous	386,477	406,400	333,029
May 28	1,026,397	1,080,786	913,087
May 21	1,016,803	1,039,070	987,306
May 14	1,029,126	1,029,748	985,879
May 7	1,024,416	996,216	983,034
April 30	1,026,440	995,408	984,073
Cumulative total, 22 weeks	21,352,566	20,919,811	20,362,618

The freight car surplus for the week ended May 23 averaged 248,771 cars, including 77,304 coal cars and 126,999 box cars.

Car Loading in Canada

Revenue car loadings at stations in Canada for the week ended May 28 totalled 53,914 cars, a decrease of 7,622 cars from the previous week and a decrease of 3,544 cars from the same week last year.

	Total for Canada			Cumulative totals to date	
	May 28,	May 21,	May 29,		
Commodities	1927	1927	1926	1927	1926
Grain and grain products	5,407	6,781	7,617	162,582	148,107
Live stock	1,550	1,826	1,752	41,776	42,498
Coal	5,164	6,135	5,978	130,206	94,858
Coke	185	311	208	7,128	9,060
Lumber	3,982	4,183	3,656	71,684	71,447
Pulpwood	1,792	1,825	2,014	89,068	67,773
Pulp and paper	2,274	2,237	2,431	46,785	53,897
Other forest products	2,724	3,026	2,633	67,626	71,332
Ore	1,446	1,528	1,981	30,445	31,484
Merchandise, L/c. l.	15,393	17,801	14,907	349,469	327,548
Miscellaneous	13,997	15,883	14,281	268,236	258,913
Total cars loaded	53,914	61,536	57,458	1,265,005	1,176,917
Total cars received from connections	37,801	38,882	37,628	822,260	788,199

The Montreal Meeting of the Mechanical Division American Railway Association June 7-10, 1927

Mechanical Division Holds Convention in Canada

Four days devoted to a comprehensive program of addresses, papers and committee reports

THE eighth annual meeting of the Mechanical Division of the American Railway Association was held at the Hotel Windsor, Montreal, Que., Tuesday to Friday inclusive June 7 to 10. The sessions were called to order by Chairman Sillcox each day at 9:30 a.m., and, excepting Friday, continued through to 5:00 p.m. with a recess for lunch. A half day's session on Friday preceded final adjournment of the convention.

Tuesday's session was opened with an invocation by the Rev. Canon Shatford. The opening address was delivered by the Right Honorable George P. Graham, formerly Minister of Railways in Canada. Abstracts of Mr. Graham's address and of the other addresses, papers and committee reports follows:

Address of the Right Honorable George P. Graham


G. P. Graham

Your chairman has said that I was Minister of Railways in the trying time. The world had trying times and the railways were affected. During these lean times Canada embarked on the greatest experiment of national ownership that was ever attempted. I was the victim of that experiment for some years, when it was unpopular, and it was hard to make men believe that it was possible for a country to own and operate a railway. But times have changed and our two great railway systems in Canada are now enjoying the sunshine of prosperity. I think that the Canadian Pacific and the Canadian National railways are managed as competently as any transportation companies in the world. any country.

The success of the transportation companies furnishes an index of the prosperity of the country. Car loadings may be dry reading to most people, but the record of how many cars were loaded and with what they were loaded each week is very interesting not only to the railway companies, but to the business men generally in

The world ought to move judiciously in its continued efforts to curtail the incomes of transportation companies. Service must be paid for at a reasonable rate. The men who put their labor into the transportation business will never return to the remuneration they had before the war, and it would not be a good thing for any of our companies or any of our countries if they did. A new era has arrived in that respect and we must adjust ourselves to the conditions which we have. It is a mistake on the part of the press or the public to endeavor to compel transportation companies to transact business at less than a fair profit.

We cannot, on this continent, hope to build our various countries or nations to that point which should be their object of attainment, unless by unity of action. Geography, if nothing else, has made it impossible for you in the United States to get along without us in Canada, or for us to get along without you.

Such gatherings as this bring men together from various nations on this continent, and you find when you sit down to discuss your problems that they are practically the same, and always will be. We cannot develop as we should unless we work to a certain extent in unison and harmony, and I am glad to know that the American Railway Association, through its members, is working in harmony in order to better the conditions of transportation. You men have to do with the equipment. On you we depend not only for comfort but for safety. At the present time men and women on this continent travel with greater speed, greater ease, more comfort, and greater safety than they ever did before in the history of transportation.

Address of R. H. Aishton


R. H. Aishton

The following is an abstract of the address of R. H. Aishton, president of the American Railway Association:

The railroads of the United States and Canada have made greater strides in the past four years in the development of their mechanical facilities than ever before in the history of the railroads.

As a result of this development the railroads of North America are being operated with more economy and with greater efficiency than ever before. Corollary to this, the public in both the Dominion of Canada and the United States is receiving the best transportation service ever accorded them by the rail carriers in those countries.

The railroads in 1926 handled the greatest freight traffic in their history but they not only did so without car shortage or other transportation difficulties but also with an ownership of fewer freight cars and locomotives on their lines than in the year before. This year they own still fewer cars and locomotives but owing to the fact they are constantly replacing obsolete equipment with cars and locomotives of more modern type and with greater transportation capacity, and the fact that both freight cars and locomotives are being used more efficiently today then ever before, the American Railway

Association believes it possible to handle the traffic of the United States for some time to come with at least 100,000 fewer freight cars than are now owned by the railroads. This statement is based on the assumption that there will be a continuation of the present economical use of freight cars and also an increase of one ton in the average load per car, which, with public co-operation, can be easily attained.

This recommendation constitutes only one of the many concrete results which have been attained by the railroads due to the large capital expenditures which they have made in the past few years in order to insure the maintenance of adequate transportation.

Not content with what has already been accomplished, however, the railroads are endeavoring to bring about still further improvements with a view of realizing still greater efficiency and economy in operation. This is prompted by the fact that in addition to what has already been accomplished by them in the way of savings, they must work for further economies which must come mainly from improvements in operation brought about largely by improved mechanical devices.

Numerous railroads, for instance, have found that electrically controlled switch machines at remote points will not only facilitate the movement of trains but will also bring about savings both in labor and in train operation which alone will pay for themselves within approximately three years. By the development of automatic signals and the elimination of delays in terminals, the movement of trains has been expedited without the necessity for additional large capital expenditures. Stronger and better freight cars are being constructed today than ever before with a view of increasing their capacity without increasing their weight. This is shown by the fact that freight cars now being built by the railroads and which have a capacity of 50 tons, weigh less than the 40 ton capacity cars which the Railroad Administration built some years ago.

The trained scientist and the mechanical engineer are now playing a greater part in the operation of the railroads than ever before. Housed in laboratories, often miles from the main lines of railroads, they are conducting extensive research work designed to bring about still further improvements and efficiencies in operation.

The Man Problem

By Samuel O. Dunn
Editor of the *Railway Age*

S. O. Dunn

When we use the word "railroad" we usually refer merely to the physical plant; but a railroad actually consists of both a plant and a personnel. These two parts of a railroad are complementary and interdependent to such a degree that there is hardly an important problem of management the solution of which does not involve changes affecting both of them. The physical property and the personnel constantly react upon and determine each other.

The principal way in which improvements in the physical plant effect economies is by reducing the amount of labor that otherwise would have to be employed. Changes in conditions of employment also often indirectly cause great changes in the physical plant. For example, formerly the wages of freight train and engine men were based upon a ten-hour day, and improvements in permanent structures and locomotives were directed mainly to making it possible to haul longer and heavier train loads between freight terminals at an average speed of ten miles an hour. About ten years ago a law was passed by the Congress of the United States making eight hours the basis of a day's pay in train and engine service. The necessity since then of paying overtime after eight hours has stimulated important changes in permanent structures and locomotives that have caused increases in both train loads and train speeds to go hand in hand and now the average speed of freight trains in the United States is twelve miles an hour.

While the physical and personnel problems of railways are thus interlocked, it is significant that, although there is much organized study and discussion of their physical problems, there is very little organized study and discussion of their personnel problems. We have a multitude of organizations representing most or all of the railways which, through committee reports and discussions at conventions, promote the improvement and better use of physical facilities; but in the reports and discussions of these organizations little or nothing is said about methods of selecting, developing, directing, promoting or compensating the personnel, and we have no organization which deals especially with personnel problems. If railway officers were as reticent about exchanging and disseminating information concerning the methods used and the results obtained in their efforts to solve other problems as they are regarding the methods used and the results obtained in their efforts to solve the so-called "labor problem," the progress made in increasing the efficiency and economy of railway operation on this continent would soon be greatly reduced.

Personnel Problems a Constant Struggle Between Employee and Employer

Why is there this marked difference in policies regarding railway physical problems and railway personnel problems? It is mainly due to the fact that there is constantly going on a struggle between the managements and various more or less strongly organized groups of employees, and that many managements fear that complete frankness regarding means being used to solve vital personnel problems would embarrass and weaken them in this struggle. The managements want wages and conditions of work so adjusted that they will have competent and satisfied employees and that the maximum amount of efficient labor will be obtained for each hour of work paid for. Employees want to avoid being required to exert themselves to excess, to get the highest practicable wages, to have promotions made without favoritism, to have security in their employment, and to have a voice in determining their conditions of work and wages. As thus stated, there is nothing unreasonable or incompatible in their attitudes. Nevertheless, there goes on between them the constant struggle mentioned, sometimes in a mild way over minor differences, sometimes in bitterness of spirit and in the form

of strikes resulting in great losses to railways, employees and public.

Struggles between employers and employees have been occurring throughout the entire history of their relationship. But in our modern age of industrialism, with its huge aggregations of capital employing great armies of men, these struggles have assumed forms and an importance that are new. I believe, however, experience has demonstrated that under the modern industrial system there is very little real antagonism of interest between employer and employee, and that if both were not greatly, but more or less unconsciously, influenced in their thought, attitude and policies by a false economic philosophy, the age-long struggle between them would be subordinated to co-operation in furtherance of their mutual interests.

The prevalence of this false economic philosophy is partly due to the fact of common knowledge that many improvements in the plants and methods of industry temporarily reduce the number of employees required to do the work affected. There is a strong natural tendency, therefore, of those who take a short-sighted view to be antagonistic to improvements because of fear that they will result in unemployment.

The Influence of Socialistic Doctrines

Of even more importance is the fact that literally millions of persons are influenced in their attitude toward the relations between employers and employees by socialistic doctrines. It may shock and irritate some for a reference to socialism to be injected into a discussion of the man problem in industry which, on an occasion such as this, should be highly practical, but I do not believe we can understand the labor problem unless we consider the extent to which it is complicated by socialistic doctrine. The philosophy of modern socialism was first given to the world in the very early history of modern industrialism. Its fundamental postulate was that labor produced all wealth, but that the employer allowed the worker to earn only enough wages to get the necessities required to enable him to work until he could produce other workers, and that the employer, as a member of the capitalist class, appropriated, or at least tried to appropriate, the value of all the rest of what was produced. On this doctrine was based the further doctrine that there would be an irrepressible struggle between the capitalist class, on the one hand, and the "proletariat," on the other, until the entire system of private ownership of property should be overthrown and some system of public ownership of property and employment of all labor substituted for it. Since, according to this doctrine, all the benefits of every increase of production in excess of what was required to enable the working class to live and produce a sufficient supply of future laborers, would tend to accrue to the capitalist class, it was sound policy for the working class to struggle to keep down as much as possible the return earned upon capital, and even to resist efforts to increase the efficiency of production, which, by increasing output per man, might increase the income of the capitalist, and at the same time reduce the number of workers it was necessary to employ. Why should a worker, who believed the employing capitalist would get all the benefit of an increase in production per man, try to increase his productive efficiency?

It is not generally realized how extensively this economic philosophy has permeated modern literature and thought regarding the relations of employer and employee, and how it affects those relations. To many, however, including not only working men but even business men, it seems obvious that in every business there is a certain amount of income to be divided between capital and labor; that the more capital gets the less labor must get; that the more labor gets the less capital must get; and that, therefore, there is a substantial element of truth in the socialist doctrine of a necessary and continuous class conflict under our present industrial system. Anybody who reads the literature disseminated by labor organizations, including those of railway employees, will see that running through most of it is the implication that under our present industrial system most invested capital gets excessive returns; that these returns are mainly due to the unjust exploitation of labor; and that not only is it plainly to the interest of labor at all times to try to improve its working conditions and wages to the greatest extent possible at the cost of a reduction in the return received by capital, but that it is by no means plainly to the interest of labor to help increase the productive efficiency of industry by doing the most and best work it can in each hour for which it is paid. We have, therefore, constantly presented the spectacle of labor trying to get its wages increased, and at the same time trying to get the work it has to do for them per hour or day limited or reduced.

Workers, Not Owners, Receive Greatest Benefit from Increased Output

Now, it is my belief, based upon what I take to be incontrovertible evidence, that in the long run on the railroads and in every other large scale industry it never has been and never will be the owners of capital and the managers of industry, but that it always has been and always will be those who work for wages, who have got and will get the great bulk of all the tangible and intangible benefits resulting from every increase in the output of industry per man-hour of labor employed and paid for, and that, therefore, it is the employee and not the employer class who should be most anxious to see efficiency in every branch of production increased by every means possible. If this is true, and labor can and shall be convinced it is true, the solution of the problem of getting the co-operation of labor in adopting and carrying out innumerable methods of increasing efficiency in all branches of industry, including that of transportation, will be made much simpler and easier. I am not guilty of the absurdity of believing that we can make every worker an economist, but I do believe it is by no means impossible to create among the working class a sentiment to the effect that in the long run that class is the chief beneficiary of increases in industrial efficiency, and that, therefore, it should do nothing to prevent, but should welcome every opportunity to help in promoting it.

We see on every hand throughout the United States and Canada evidence that the expenditures of the working class of these countries have greatly increased and that their living conditions have been greatly improved within the last twenty years. Let us see what has occurred on our railways meantime to help bring these things about. For convenience I shall use facts regarding the railways of the United States, but those regarding the railways of Canada would show the same thing. Tons carried one mile and passengers carried one mile are the products of a railroad, just as coal is the product of a coal mine or wheat the product of a farm. Going back two decades we find that in the year ended on June 30, 1906, the average number of revenue tons carried one mile by the railways of the United States per person employed was 145,127 and the average number of passengers carried one mile per person employed was 16,782. In 1926 the number of tons carried one mile per employee was about 249,000 and the number of pas-

sengers carried one mile per employee about 19,910. If we assume, as is commonly done, that carrying a passenger one mile is roughly equivalent to carrying three tons one mile, we find that in 1906 the number of "traffice units" of service rendered by the railways per employee was 195,473, and in 1926, 308,730, an increase of 58 per cent.

These increases in output were due both to enlargements and improvements in the physical plant and tools and the work of the entire personnel. The best available measures of the physical capacity of the railways are the tractive force of their locomotives and the tonnage capacity of their freight cars. Total locomotive tractive force per employee in 1906 was 817 pounds and in 1926, 1,445 pounds, an increase of 77 per cent. Total freight car capacity per employee in 1906 was 39 tons and in 1926, 59 tons, an increase of 51 per cent. It may reasonably be assumed that these increases are typical of increases in capacity that were made in all parts of the railway plant; and they were accomplished, of course, by the investment of capital. The average investment per employee in 1906 was $8,088, and in 1926 it was $12,991, an increase of 61 per cent.

The increase in the total operating revenues of the railways per employee between 1906 and 1926 was from $1,540 to $3,571, or 132 per cent. This was due to the average increase of 58 per cent in the output of transportation per employee and to average advances in freight and passenger rates of 47 per cent. Now, how did the employees of the railways and the capital invested in them share between them the benefits resulting from the increase in total earnings due to both increased output and advance in rates? If the employees had shared only in proportion to the increase in output per employee and the advances in the rates the increase in their average annual compensation would have been 132 per cent, but in fact the average annual compensation per employee increased from $596 in 1906 to $1,656 in 1926, or 177 per cent. Net operating income is the return earned on the capital invested in the industry, and it amounted in 1906 to $480 per employee. If it had increased during the last twenty years as much in proportion per employee as did the average wage paid, or 177 per cent, it would have amounted in 1926 to $1,330 per employee. If it had increased only as much in proportion as the average operating revenues per employee, or 132 per cent, it would have amounted in 1926 to $1,108 per employee. It actually was in 1926 only $682 per employee, an increase since 1906 of only 42 per cent. Since the increase in investment *per employee* was 61 per cent and the increase in net operating income *per employee* only 42 per cent, it follows that there was a decline in the average return earned upon each dollar of capital invested. Average return upon investment in 1906 was 5.9 per cent, and in 1926 only 5.3 per cent.

These facts show beyond all question that during the last twenty years the employees of the railways have received far greater benefits from the improvements in the properties and in their operation than those who, by the investment of capital in them, have made these improvements possible. Twenty years ago the employees as a whole received an income from the industry 24 per cent greater than the income received by capital, while last year the employees received 140 per cent more than capital. Probably in most other industries the increase in the incomes of employees has not been so much greater in proportion than the increase in the income of capital as it has been in the railroad industry, because the railways have been subject to a special form of regulation directed mainly at limiting the return received by the capital invested in them. But in practically all other industries wages have increased much more in proportion than the income from invested capital. In other words, the facts demonstrate that under our present industrial system it is the employee, not the employing class, that gets the lion's share of the increases in income and purchasing power resulting from large and wise investment of capital, good management and sane co-operation between employers and employees to intensify industrial efficiency. During most of the period reviewed the difficulty of raising capital for the railroad industry constantly increased because of excessively restrictive regulation of the return upon it. Undoubtedly if the percentage of return allowed to be earned had been larger the amount of capital invested would have been larger, resulting in improvements in facilities that would have effected still greater savings of labor, fuel and materials, thereby making possible even higher wages for employees or lower rates for the public.

Safety and Improved Working Conditions Effected by Increased Capital Investment

In addition to the increase in the purchasing power of their wages and reductions in their hours of work, railway employees have been benefited in other ways by the improvements in the plants and in operation. Their work has been made safer. The amount of physical exertion required to do their work has been reduced in many ways. Many improvements have been effected partly or wholly by the investment of capital, and, while most of them have been introduced to increase efficiency and save expenses, they have had incidentally the effect of reducing the amount of back-breaking labor required from employees and of making their work more pleasant and healthful.

It is hardly necessary to say that a large production per employee in the railway and other industries does not result in proportionately high, or even proportionately higher, wages merely because of a generous disposition of employers to pay high wages. Nor are advances in wages mainly due to the organized pressure of employees for them, because without increases in average output per employee there would soon be no source from which the means of paying higher "real wages"—that is, wages of greater purchasing power—could be derived. Increased production per employee results in increased average real wages per employee mainly because of the operation of economic laws over which neither employers nor employees have much influence. Increased production will not increase the prosperity of industry without increased consumption of the products of industry, and since those who work for wages constitute the largest single class of consumers, they must, if industry is to prosper, be paid wages high enough to enable them to increase their consumption as production increases. Obviously, however, high production must precede and thereby make possible the wages of greater purchasing power required to enable the employee class to become larger buyers and consumers of necessaries, comforts and luxuries. It is the large average purchases and consumption per person to which we refer when we say that the standard of living in Canada and the United States is the highest in the world, and it should be obvious that this high average consumption is made possible only by high average production.

I have at such length emphasized and elaborated upon the economic effects upon the working class of increases in industrial efficiency because the most serious obstacle

always encountered in almost every effort to increase railroad efficiency and economy has been an antagonistic attitude of employees due to a widespread belief, more or less clearly held and expressed, that while increases in efficiency would be to the advantage of the railways, they would not benefit, and probably would be contrary to the interests of the employees. The most effective means ever used to enhance the economy of operation has been that of increasing ton-miles per train-hour through improvements in roadway, tracks, signals, cars and locomotives that have made it possible to increase the loads of freight trains and to move them more rapidly. This, of course, reduces the number of trains, of locomotives and of employees that otherwise would be required to handle traffic. Employees' organizations resort to various means to prevent these improvements from producing their natural results. For example, in train service wages are based on miles as well as hours, and in a large part of the country they effectively insist upon a limitation of the number of miles that a locomotive engineer can make in a month, the purpose being to divide the work among an unnecessarily large number of men. Among the effects are to restrict maximum and average monthly and annual wage earnings, and thereby strengthen demands for increased hourly and mileage rates of pay. The trainmen's organization has succeeded in many states in getting laws passed requiring the railways to employ an unnecessary number of men in the crews of long trains, and is still engaged in trying to get such laws passed, or even laws arbitrarily limiting the length of trains. Such laws tend, of course, to defeat the main purpose of all improvements made in locomotives and other facilities to enable freight to be handled in larger trainloads, which is to increase the amount of transportation produced with a given amount of labor.

The Effect of Seniority

Many other illustrations of the same general character might be mentioned. The best possible organization of industry is essential to the highest practicable efficiency, and good organization consists largely or mainly of putting in every position, whether in the lower ranks of the employees or the higher ranks of the officers, the man best qualified to perform the duties of that position. On all railways in some branches of the service and on many railways in most branches of it, however, representatives of the employees strongly insist upon promotions according to seniority. While usually promotion by seniority is in the interest of efficiency, because of the longer training and experience of the senior man, this is so often not the case, because of wide differences in the natural initiative, ability and energy of men, that the rigid adherence to seniority favored by many organizations of employees is plainly contrary to efficiency. It is significant that in the selection of officers of their own organizations employees do not adhere to seniority with the strictness with which they try to get the railways to adhere to it. The prevalence of seniority rules now presents one of the greatest difficulties encountered in putting men of good education and natural ability in supervisory positions while they are still young enough to get the training and experience they should have to fit them for higher official positions.

One of the strongest incentives that can be given men to work with maximum efficiency is that of paying them in proportion to the amount and character of the work they do. This incentive is given in many industries by payment on piece work bases of various kinds. The amount of piece work done in the railroad industry is relatively very small. The amount of wages paid to all employees of Class I railroads in the United States last year—excluding officials—was $2,859,000,000, and of this only about $80,000,000, or less than 3 per cent, was for piece work. It seems significant that the average hourly earnings of piece work employees were 83.7 cents while the average hourly earnings of all employees paid on an hourly basis were 58.7 cents. There are some valid objections to piece work, but no doubt the principal reason that prevents it from being more extensively used in the railroad industry is one that is not valid, namely, that it tends to reduce the number of employees required to do a given amount of work. No doubt it does tend to have this effect, but the belief that it is, therefore, inimical to employees is but another illustration of the widely prevalent but economically unsound belief that industrial efficiency is advantageous to capital but not advantageous to labor.

Almost every increase in railway efficiency that has been accomplished has reduced the number of hours of human labor required to produce a given number of ton-miles and passenger-miles, but this has never actually resulted, excepting temporarily, in a reduction of the total number of employees. There was a large increase in their number during and immediately following the war owing to the general introduction of the eight-hour day and other causes, and a correspondingly large reduction as a result of the industrial depression and the increase in the efficiency of operation which followed the return of the railways to private management. In 1926, however, the number of employees of the Class I railways of the United States was larger than in any other year in history, excepting the war years and in 1923, when it was affected by the results of the shop employees' strike of 1922. Excepting under abnormal conditions increases in railway output per employee, resulting from more efficient operation, have been offset by increases in the total amount of traffic to be handled. There would have been a much larger increase in traffic, and consequently in the number of employees required, within recent years if so much freight and passenger business had not been diverted from the railways to other means of transportation, the effectiveness of which in competing with the railways has been mainly due to government expenditures on highways and waterways.

What does this discussion suggest as to the means which should be adopted better to solve the vitally important man problem as it is presented in much the same form on our railroads and in all other industries in which men work for wages? There is much talk about trying to get the co-operation of labor in increasing efficiency. There is much talk about trying to improve "employee relations" and "human relations." But all men are more or less selfish. There is very little difference in this respect between the bankers of Wall street, the managers of industry, the labor leaders and the various classes of wage earners. When you go to a man, even though a good friend, with a business proposition, he wants to know at once, not what you are going to gain, but what he is going to gain, if he accepts it.

Now, the relations between a railway and its employees are primarily business relations. The railway hires every man on its pay roll for its own business purposes, and every man on the pay roll hires to it to get as much wages as he can. Therefore, when the management proposes to the employees that they shall do certain things to increase efficiency it is reasonably to be expected that the employees will want to know how they will be benefited by doing these things, just as when the employees ask for higher wages they should reasonably expect that the managements will ask what the em-

ployees are doing or intend to do, or what conditions exist, to justify paying them more. There is a valid reason that the managements can always give why employees should support them in every practicable way in increasing efficiency, and this is the one I have tried to illustrate by the citation of facts of railway economic history—namely, that in the long run much the greater part of the benefits of every form of increased efficiency in transportation and production goes to the workers in the form of better and safer working conditions and of wages that will increase their purchasing power. It is because labor generally does not know this that we so often find it harmfully antagonistic to more efficient machinery and methods.

The true definition of railway efficiency from the standpoint of both management and employees is, the largest practicable production of ton-miles and passenger-miles in proportion to the number of man-hours and of tons of fuel and materials used in rendering railway service. Broadly speaking, there are two ways of increasing efficiency as thus defined. The first is by the investment of capital in the innumerable ways by which labor, fuel and materials can be saved. In order that all the capital may be raised that can be effectively employed for these purpose it is necessary that each railway shall earn an amount of net return that will make it an attractive concern in which to invest capital and in their own selfish interest the employees should always support the managements in their efforts to keep total earnings high enough and operating expenses and taxes low enough to produce an adequate net return on capital. Capital consists simply of the tools with which the personnel works, whether they be small tools in shops or such great tools as locomotives. The better these tools are the larger, if they are skillfully used, will be the output of transportation per employee, and if freight and passenger rates are reasonably regulated, the larger also the total railway earnings per employee out of which the average wage per employee must be paid.

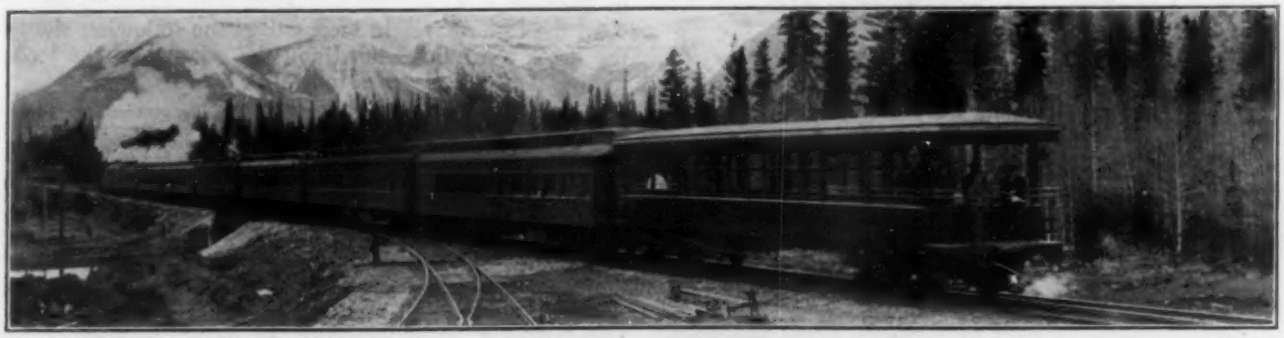
The second important means of increasing efficiency is that of so organizing the personnel, and securing such co-operation between all the classes and individuals composing it, that the physical facilities provided by capital will be used with the greatest practicable skill.

The needed organization and co-operation of the entire personnel can never be fully attained until labor in general has the right idea regarding its own true interest. It will never have this right idea until it is given it by education. The resistance that has been offered in the past, and is offered now, to so many efforts of management to increase efficiency through improvements in plant, promotion according to merit and the payment of wages according to the work done, will continue. Great exertions will have to be made to overcome it, and it will be overcome with only partial success as long as so many working men continue to believe that improvements in plant, in organizations and in methods are intended and adapted mainly or solely to enabling capital to get more profits by making part of the employees do more work, and throwing the rest out of their jobs.

Improved Relations a Problem of Employee Education

If seems to me, therefore, that the man problem in industry is primarily one of education. There is great need for better education of supervisory officers as to the effects produced on wages and conditions of work by the expenditure of capital and brains in improving facilities, organization and methods. Most supervisory officers are fully capable of understanding the significance of such facts when presented to them, and in their constant contact with the more intelligent employees can transmit them and make them understood. The magazines published by railways afford an excellent means of disseminating among all classes of employees correct information regarding their true relations with their employers and their true interests. Many railways seem to fear to try to educate their employees regarding such matters lest they be criticized for carrying on "propaganda." It is strange how many employers there are who know that other persons disseminate "propaganda" among their employees, but consider it unwise or not worth while to give them facts about the industry in which they are employed and about what determines the prosperity of both the industry and its employees. It seems to me that the lasting and real success of efforts of every kind to improve relations with employees, and thereby promote efficiency of operation, must be based upon education of employees which will convince all of them who are capable of understanding simple economic facts and reasoning about them that it is relatively more to the interest of wage earners than any other class of persons to have increased as much as practicable the efficiency of all branches of transportation and production.

Hand in hand with this general educational work among employees there should be carried out more experiments with and more studies and discussions of methods designed to increase the efficiency of the personnel. Throughout the United States and Canada railway managements are experimenting more or less with plans of co-operating with both standard labor unions and so-called "company unions," with employee representation, with employee ownership of securities, with various methods of educating employees, with different schemes of piece work, of selection and promotion of employees, and so on. They are, however, reticent about making many of these plans public except in broad outline, and especially reticent about discussing



C. P. R. Train with Open Observation Car, Near Banff, Alta.

in any detail the methods used and the results obtained. This reticence, as I have already intimated, is plainly due to apprehension regarding the possible results of talking too much about efforts being made to solve the man problem. But, if as I believe is true, most of them tend and are intended to promote the interests not only of the railways, but even to a greater extent those of the employees, why would it not be desirable to have the facts about them and their results publicly presented and compared in order that methods shown to be producing the best results might have a better chance to become widely known, understood and adopted?

It seems to me that in the interest of the greatest efficiency, and therefore, the most effective promotion of the welfare of both railways and employees, the time must come when problems of personnel and methods used in their solution will be as fully, frankly and publicly studied and discussed as other problems and methods of railway administration, construction, development and operation.

Chairman Sillcox Speaks on More Intensive Use of Equipment

It is indeed a privilege for the Mechanical Division of the American Railway Association to be assembled in Montreal for the purpose of conducting its business and carry on its work of assisting in improving the general character and operation of the railway industry. The benefits to be derived from the work of this association, it is hoped, will be equally effective on Canadian and United States lines, since the membership is composed of railways operating in both countries.

We are today attending conventions to obtain new ideas for self improvement and we are endeavoring to

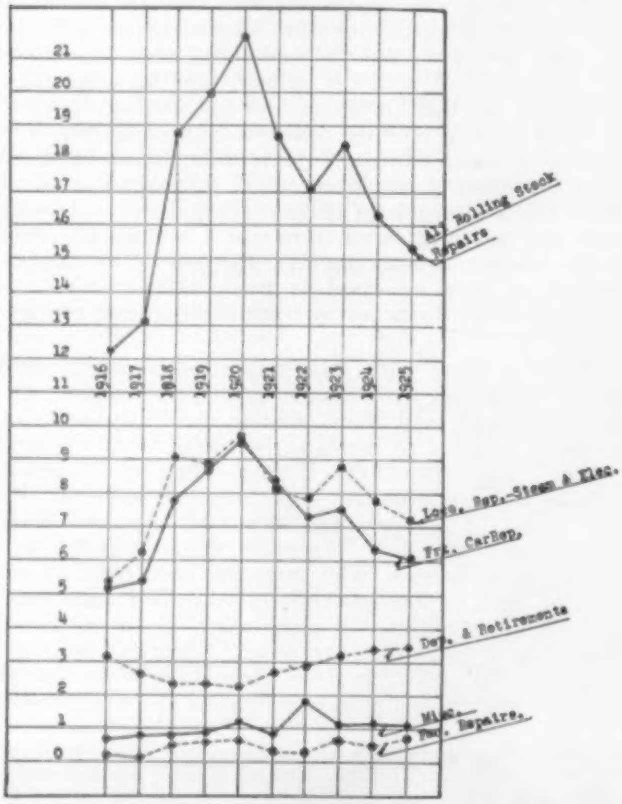


Chart C—Cost of Maintenance of Equipment in Per Cent of Operating Revenues

learn how to do better work in the future than in the past. The man who misses that point in a convention is disregarding the very reason for his attendance. We need to give due credit to the value of service rendered the railway industry by manufacturers of equipment and specialties and of the part they have contributed towards its upbuilding. In meeting conditions as they exist, at this time, we have much to do in the way of co-ordinating the use and adoption of new tools and devices with existing practices and plants in order to gain the greatest practical benefit for effective operation. Every precedent of the industry is subject to question in the light of changed conditions and the fact that we have always done something in a given way is a good reason for questioning that practice with a view towards improvement.

From the operating ratios and trends for Class I carriers in the United States it is apparent that the transportation expense ratio was 34.25 in 1926 and 32.60 in 1916, the difference still being 1.65. In the same way maintenance of equipment ratio was still 3.43 greater, maintenance of way 1.85 and all other expenses 0.65 greater than in 1916. The difference of 3.43 for maintenance of equipment is somewhat due to the difference of 0.3 in depreciation and retirement charges and these will not decrease for some years to come because of the price range of equipment acquired since 1916.

Trends in Maintenance of Equipment Expenses

In the cost of maintaining equipment this may be divided roughly into (1) repairs, (2) depreciation and retirements, (3) miscellaneous such as superintendence, injuries to persons, stationery and printing, joint facilities, etc., and (4) repairs to facilities used for maintaining equipment.

This is illustrated by chart "C" in per cent of operating revenues. Repairs to rolling stock increased to a larger extent than charges for depreciation and retirements with a constantly increasing ratio for repairs to maintenance facilities due to lack of turnover and greater demand being made upon obsolete tools and power generating facilities than ever before. Locomotive and freight car repairs are shown separately on this chart to indicate to what extent they affected the total and this indicates that the proportion expended for freight car repairs has decreased more rapidly since 1921 than locomotive repairs due to a larger percentage of new units added in the case of freight cars as compared with locomotives. Passenger car repairs increased 33.8 per cent in ratio, the difference being that the ratio was 1.024 in 1916 and 1.370 in 1925.

In the case of freight locomotives the following shows the gross ton miles hauled and the relation of the locomotive ton mile to gross ton miles hauled:

	Billion gross ton-miles hauled	Billion net ton-miles hauled	Billion loco. ton-miles run	Per cent loco. ton-miles: To gross ton-miles hauled	Per cent loco. ton-miles: To net ton-miles hauled
1921......	869	761	108	12.4	14.2
1922......	928	815	113	12.1	13.8
1923......	1,124	987	137	12.1	14.0
1924......	1,086	954	132	12.1	13.8
1925......	1,162	1,023	139	11.9	13.5
1926......	1,246	1,099	147	11.8	13.3

This shows that more work has been done by individual freight locomotives and that the gross ton-miles hauled per locomotive ton-mile, arrived at by deducting the net ton-miles from the gross ton-miles, in-

cluding locomotive and tender to indicate the locomotive ton-miles, resulted in a lesser per cent of the total in 1926 than in 1921, or a reduction from 12.4 per cent to 11.8 per cent, a benefit of 5 per cent resulting. At the same time the per cent of locomotive ton-miles to net ton-miles decreased from 14.2 per cent to 13.3 per cent, a benefit of 6.3 per cent resulting. The gross ton-miles in 1926 were 43 per cent more than in 1921. The net ton-miles were 44 per cent more. It is thus apparent that the relation of net ton-miles carried to total train weight has improved. The locomotive ton-miles in this period increased only 36 per cent as compared with 43 per cent for total gross ton-miles, this being another way of expressing the greater efficiency obtained. The average miles run per locomotive per year decreased in the face of this improvement in performance, indicating the need for close study and positive methods to be applied in assisting still greater utilization of the transportation plant. The aggregate tractive force capacity of all classes of locomotives, that is, freight, passenger and switch, increased 10 per cent in the same period, which is less than the business increase.

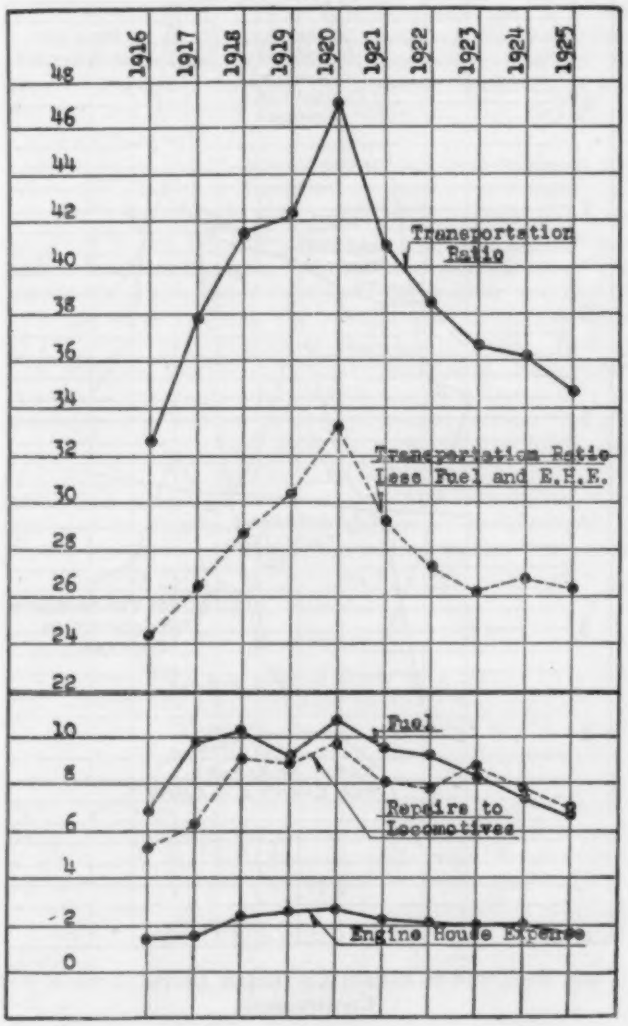


Chart D—Transportation, Fuel, Enginehouse Expense and Locomotive Repair Cost Ratios

It is interesting to note, in this connection, the cost per locomotive mile for repairs, fuel and enginehouse expense from 1916 to 1925, inclusive, as shown in the following tabulation.

Cost Per Lccomotive Transportation Service Mile

	Repairs, cents	Fuel, cents	Enginehouse expense, cents
1916	11.43	14.56	3.02
1917	14.10	22.43	3.85
1918	25.74	29.46	6.94
1919	29.35	30.05	8.37
1920	35.01	39.69	10.03
1921	30.70	35.53	8.96
1922	29.25	34.11	8.21
1923	33.12	31.18	7.66
1924	28.89	27.00	7.30
1925	27.88	24.72	6.90
Per cent in 1925 over 1916	128	69	144

In this respect the cost per mile for fuel was 69 per cent greater in 1925 than in 1916, whereas the cost of enginehouse handling was 144 per cent greater, from which it is evident that improvement in roundhouse facilities and methods is an important issue for consideration. At the same time in this respect locomotive repairs were 128 per cent greater.

Enginehouse Expense Still High

Enginehouse expense has not decreased in cost as rapidly as it should, particularly in view of the fact that the increased utilization of power should reduce the frequency of enginehouse care in relation to mileage run. Terminal facilities are of the greatest importance in this respect. Improvements along this line may be considered from two viewpoints, one being the design and equipment of the enginehouse plant and the other being the number of roundhouses needed for a given service. In the latter case, it has been found that the average distance between roundhouses ranges from 60 miles on some lines to more than 100 miles on other lines and it is, at once, apparent that the cost of enginehouse expense, in relation to mileage run, will be high or low according to this general situation. In the other case, it is of great importance that track layouts be such as to reduce hostler service to a minimum since this is a rather large proportion of enginehouse expense. This applies to inbound and outbound tracks, ash pit location, coaling, watering and sanding facilities, turntable capacity, etc. Aside from these elements, the handling of cinders is also a large expense and devices for reducing labor cost are desirable. The cost of boiler washing is a particularly large element in this expense and water pressure, together with hot water facilities, determines the efficiency of this work, affects the cost and also affects the fuel performance in a measure. Hot water washout plants result in making roundhouse stalls available to a greater extent through speeding up the operations and also save locomotive fuel used in firing up. The installation of such facilities has added to the improvement in fuel performance in recent years. The indications are that enginehouse expense will eventually cost approximatly 6 cents per mile or less until there is an increase in the number of new or rehabilitated pivotal terminal facilities provided for more efficiently handling locomotives when a further reduction in cost per mile may be expected.

Freight Cars

Progress has been made in the design, maintenance cost and performance of freight train cars in the ten year period referred to. Car shortages have practically disappeared. At the same time the number of freight cars owned by Class I carriers increased only 4.7 per cent, but the aggregate carrying capacity increased 16.3 per cent while the average carrying capacity increased from 41.0 tons to 44.8 tons, or 9.2 per cent. The proportion of the total cars which are of steel construction, that is, all steel, steel framed or steel underframe, etc., increased from 57 per cent to 73 per cent.

The cost of maintenace increased from $83 per car to

$156, or 88 per cent. The cost of maintenance per car mile increased from .81 cents to 1.39 cents, or 71 per cent and during this time the average miles run per car increased from 10,000 to 11,150, or 9 per cent. It has been shown that the maintenance cost of freight cars declined more rapidly than that of locomotives in the past five years and the conditions bringing this about differ considerably in the matter of policy. The life of a freight car is about two-thirds that of a locomotive; this at least has been the past experience. For that reason the renewal periods occur more frequently and obsolescence is a greater factor. The rate of turnover of freight cars has been found to be high on some railroads and where this has been consistent with what has been needed the maintenance cost has been reduced very materially. The following tabulation shows the per cent of total cars retired and acquired in each year for the past ten years and other elements which affected maintenance and performance:

	Average rate of turn over, per cent	Per cent cars of steel	Average carrying capacity in tons	Repair cost per car-year, dollars	Repair cost in cents per car-mile	Repair cost per aggr. ton capacity dollars	Ratio of repairs to oper. rev., per cent
1916..	5.1	57	41.0	83	.81	2.06	5.288
1917..	3.8	61	41.5	97	.93	2.28	5.414
1918..	2.9	61	41.6	164	1.70	4.00	7.927
1919..	2.9	62	41.9	186	2.08	4.50	8.700
1920..	2.3	65	42.4	252	2.54	6.04	9.574
1921..	2.8	66	42.5	199	2.29	4.71	8.457
1922..	4.9	67	43.1	176	1.90	4.12	7.300
1923..	9.2	71	43.8	204	1.85	4.70	7.560
1924..	5.8	73	44.3	160	1.52	3.66	6.433
1925..	5.3	73	44.8	156	1.39	3.52	6.097
Per cent over 1916....		29	9.2	88	71	70	15

These trends are illustrated on chart "F" which indicates that the turnover has affected the cost of repairs in that the cars of wooden construction have been retired very largely since 1922. The characteristics of turnover trends will change somewhat as the proportion of cars of steel construction become larger, as this may increase the average life, provided current repairs are adequately maintained.

The effect of car construction and maintenance on train performance is shown in the following tabulation as to gross tons per train, excluding locomotive and tender, net tons per train and the resultant weight of cars per train:

	Gross tons per train	Net tons per train	Car. wt. per train	Per cent net	Per cent car wt.	Frt. ton-miles per loaded car mile
1921......	1,435	651	784	45.3	54.7	34.2
1922......	1,466	676	790	46.1	53.9	39.7
1923......	1,539	713	826	46.3	53.7	40.3
1924......	1,588	715	873	45.0	55.0	44.3
1925......	1,620	744	876	45.9	54.1	44.4
1926......	1,737	772	965	44.4	55.6	...
Increase.	21 per cent	18 per cent	23 per cent			

This shows that the per cent of car weight to total train load has been increasing and the per cent of net load carried has been decreasing and that the question of car construction in relation to dead weight is before us to a marked degree. It is necessary to await the results of the future to determine whether the question of car weight and design is going to result in a cheaper transportation cost from this viewpoint. We are, nevertheless, faced with the fact that in this period gross tons per train increased 21 per cent, while net tons per train increased only 18 per cent and at the same time car weight increased 23 per cent. Much has been said about obtaining greater loading per car, but this is a traffic problem and we have been concerned with the car strength in relation to train performance with the hope that the average load per car would increase in proportion and thus compensate for the work which it has been necessary to do to operate larger trains with greater reliability of movement. The strengthening of cars has been a contributing factor in the reduction of transportation expense, even though the average load may not have increased the earnings per car as desired. The load factor has not increased with the load carrying capacity, but the net ton-miles per freight car mile increased approximately 30 per cent in the latter portion of this period.

In the matter of freight car maintenance much can be done in classifying freight equipment by age, character of construction, frequency of heavy repair work, etc., so as to bring about heavy repairs in a balanced manner. A study of the relation of light repairs to heavy repairs

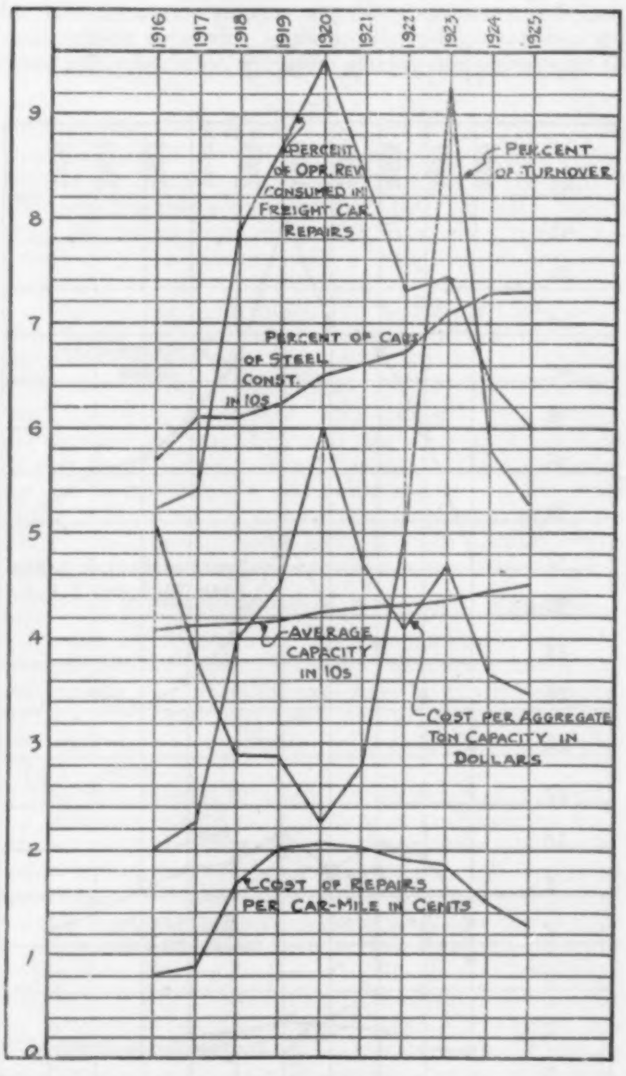


Chart F—Trend of Freight Car Repair Costs, Turnover and Construction

develops the fact that with a given ownership the character of construction will lend itself to a rather definite period of reconditioning. Progress along this line can be made to a considerable extent, but it involves the regulation of shop forces as between light and heavy work to permit of establishing more definite plans for providing facilities of proper capacity. While this has been worked out in a general way, much can be done to concentrate heavy freight car repairs and reduce the cost by reason of volume handled somewhat similar to the back shop arrangement for locomotives. Any attempt to do heavy repair work at light repair points will naturally increase the cost of such work.

The number of passenger train cars owned by Class I carriers increased only 4.8 per cent in the past ten years.

The character of ownership as to types of cars shows that the number of coaches increased only 0.4 per cent, dining cars increased 8 per cent, baggage cars increased 29 per cent and miscellaneous types increased 14 per cent in this period, but combination cars remained practically the same, and there was a decrease in the number of railroad owned emigrant, parlor, sleeper and postal cars. The number of cars of steel construction was 32 per cent of the total in 1916 and this increased to 51 per cent in 1925.

With the increase in the number of steel constructed cars, there has been practically no appreciable decrease in maintenance cost, and we are, therefore, confronted with the problem of further improving the character of materials used so as to reduce the heavy repair frequency. The major portion of repairs to passenger cars is heavy repairs, and in this respect passenger car maintenance differs in character from that of locomotives and freight cars. That being the case, the question of passenger car designs and material is very important and should be given careful study.

Very little, if any, improvement has been made in the character of repair facilities to handle passenger car work. It would seem well worth while to have this matter studied for the general good, and each carrier can well afford to go into this question very fully. The efforts along this line will be well worth while and should be made so as to bring the relative cost of maintenance of passenger cars to a more satisfactory basis. In certain sections, due to competitive conditions, the proper upkeep of passenger train cars is almost a first call upon management, because where passenger service is not maintained upon a high level, in such circumstances, the railroad may fail largely in attracting an adequate proportion of freight business and no members of the railroad family have to bear this urge more peculiarly than do the mechanical officers, thus adding to their expenses for the good of the railroads as a whole, being in substance a form of public contact.

Summary

The year 1916 was taken merely as a matter of a ten year comparison and that year in itself was no particular criterion. However, we are interested in the actual cost of repairs and the relation of the cost of maintenance and operation to operating revenue. When using the latter as the basis, it has been found that locomotive repairs consumed 36.8 per cent more of every dollar earned in 1925 than in 1916, passenger car repairs consumed 33.7 per cent, freight car repairs 15.3 per cent, enginehouse expense 28.1 per cent and transportation expense 7.1 per cent, with a decrease of 4.7 per cent in the cost of fuel.

Locomotive repair costs can be reduced by owning and maintaining only a sufficient number for the business handled and having large locomotives and maximum utilization in freight service consistent with a balance between transportation expense as to trainmen, repairs, enginehouse expense and fuel consumption; and having maximum utilization of passenger power with as small a number of units as is consistent with the business and of a size not too large for the trains handled.

Passenger train car repair costs can be reduced by improving materials and design with a view to obtaining greater service between heavy repairs and at the same time increasing the mileage performance by better utilization so as to keep to a minimum the number needed for the service.

Freight train car repairs can be reduced by more systematic attention, maximum utilization and proper construction. Questions of design are being given careful consideration by this association and work along this line has shown marked results. Repair costs are affected by the number of cars maintained and it is imperative that the number be reduced to actual requirements. It is possible to obtain greater utilization of freight cars because the mileage run per car per year is still too low. Giving cars major repairs at proper intervals to avoid running them beyond the major repair period, systematizing heavy repair work and reducing the amount of damage to cars in trains and yards as well as by shippers should result in reducing the cost.

Enginehouse expense can be reduced by operating only those terminals which are actually needed, accomplished by increasing the length of runs and by improving terminal facilities actually required.

Doubtless, further savings in fuel cost will be made in the future by increasing the locomotive performance and decreasing the turnings in relation to the mileage run.

Transportation expense has a considerable bearing upon maintenance expense as the two are more or less related. The utilization of power and cars can be increased and while this may mean larger and fewer trains, the question of balancing the savings from such operation with what may be incurred in train and engine crew overtime as compared with running lighter and more trains to reduce overtime of trainmen is one that, if solved, should reduce transportation cost accordingly in relation to equipment performance.

Much remains to be done by this and other railroad associations in the matter of improving operating and maintenance conditions. The unit rate of revenues and the revenue volume do not fluctuate uniformly with the unit rate of expense and consequent expense volume, but the work of improving the performance and reducing the cost will constantly remain before us and efforts along such lines are laudable.

Report of General Committee

The membership of the Division at the present time includes 206 railways, representing 398 memberships in the American Railway Association, and, in addition thereto, 211 railroads, associate members of the American Railway Association. These railroads, members and associate members of the American Railway Association, have appointed 1,241 representatives in the Mechanical Division. In addition there are 967 affiliated members and 164 life members in the Division.

Manual of Standard and Recommended Practice

The revision of and additions to the Manual of Standard and Recommended Practice as a result of recommendations of committees at the 1926 annual meeting as approved by letter ballot have been issued in the form of looseleaf pages to be inserted in the Manual.

Interchange Rules

The recommendations of the Arbitration Committee and the Committee on Prices for Labor and Materials, approved at the 1926 annual meeting, were incorporated in the Rules of Interchange, some by supplement issued August 1, 1926, and some in a reissue of the rules effective January 1, 1927.

Periodical Repacking of Journal Boxes

The provision in Interchange Rule 66 making the car owner responsible for the cost of periodical repacking of journal boxes approved in the report of the Arbitration Committee at the 1926 Annual Meeting was considered by your committee and the effective date extended to May 1, 1927, in the Interchange Rules issued January 1, 1927. This effective date has since been

extended to May 1, 1928 as announced in Circular No. D.V.-505. These extensions have been made to enable car owners to complete attention to their own equipment and also to enable action to be taken with respect to revision of the present recommended practice for packing of journal boxes as will be recommended by the Committee on Lubrication of Cars and Locomotives.

Loading Rules

The recommendations from the Committee on Loading Rules, considered at the 1926 Annual Meeting and approved by letter ballot of the members, were incorporated in a reissue of the rules issued, effective January 1, 1927. In addition, upon recommendation from the Committee on Loading Rules, a supplement to the rules was issued, effective May 1, 1927, covering certain modifications. These modifications were all developed with the co-operation of the shippers and were felt to be of sufficient importance to be made effective immediately without awaiting the usual letter ballot action.

Tank Car Specifications

The tank car specifications containing revisions approved by letter ballot last year have not been reissued for the reason that the Interstate Commerce Commission is issuing specifications covering the tanks of such cars used for transporting dangerous commodities. It was felt advisable to wait until the Interstate Commerce Commission's specifications were issued before issuing the American Railway Association specifications, so there would be no conflict. The Committee on Tank Cars is revising the specifications of the Association to cover tank cars not used for the transportation of dangerous articles and to cover underframe, truck and other car construction details of all tank cars.

Mechanical Inspection Department

The mechanical inspection department of the division has continued, throughout the year, making investigations covering repairs to foreign cars and billing therefor. Where definite overcharges have been found as a result of these investigations, refunds have been made to the car owners, in accordance with the billing regulations of the Association.

Welding Rules

In accordance with authority received from the individual railroads the General Committee has arranged to represent the railroads in negotiations with the Bureau of Locomotive Inspection relative to welding rules.

Joint Investigation of Tank Car Appliances and Devices

In co-operation with the American Petroleum Institute and the American Railway Car Institute, Mr. D. V. Stroop of the United States Bureau of Standards has been employed for a limited time to conduct tests and investigations of tank car appliances and devices.

The International Railway Association

The following questions have been submitted by the General Committee for discussion at the Meeting of the International Railway Association at Madrid, Spain, in 1930:

1—Future development of locomotives with high boiler pressure, either compound or with limited cut-off.
2—Use of aluminum alloys for passenger cars.
3—High speed electric locomotives.
4—Development of Diesel-electric locomotives.

Rule 112—Settlement for Rebuilt Cars

The committee in its report last year advised the members of the complaint filed by the Bangor and Aroostook relative to the rules of the association governing the settlement for cars destroyed and of the arrangement made for defending the rules before the Interstate Commerce Commission. This hearing has been held, but no decision has been handed down by the Commission to date.

Elimination of Brake Pipe Angle Cocks from Passenger Equipment Cars

The letter ballot recommending the elimination of angle cocks from passenger train cars failed to receive sufficient votes for adoption, the vote being: in favor, 596 votes; against, 440 votes.

The members are urged to make definite tests to convince themselves of the feasibility of this proposition and the matter will be submitted again to letter ballot at a later date.

Limit Load Stenciling

The rule relative to stenciling freight cars to show load limit apparently is being followed up very rapidly. It is urged, however, that each car owner canvass the situation with a view of completing this stenciling within the time limit.

Study Covering the Cost of Transferring Bad Order Cars

The committee considered jointly with the General Committee of the Transprotation Division question of economic loss in transferring bad order cars, and as a result of this joint consideration, there has been submitted to the General Committee of the Operating Division a tentative formula covering the elements of cost involved, .with the recommendation that this formula be applied to the transfers at a number of important gateways to develop actual cost of transferring bad order cars when all items of cost are included, and after this application of the formula has been made recommend such changes, if any, which may be necessary to make it a practicable formula.

Investigation of the Rules for Car Hire Settlement Between Carriers, I. C. C. Docket No. 17801

The first hearing in this case was held at Washington, March 8 to 12, 1927, inclusive, and was devoted almost entirely to the presentation of general testimony by the Short Line Association in support of its request for a modification of Per Diem Rule 6 involving settlement between subscribers to the Per Diem Rules Agreement and their non-subscribers connections. Some individual cases were also heard, and most of them involved requests of individual short line railroads to be permitted to make settlement for car hire in accordance with the so-called Birmingham Southern Rules. There was presented by the special committee on behalf of the American Railway Association general testimony in support of the Per Diem Rules.

It is expected that further hearings will be held in various sections of the country, but the time and place of such hearings have not yet been announced by the Interstate Commerce Commission.

Designs for Standard Cars—Location of Safety Appliances

In designing standard box cars the Committee on Car Construction was confronted with the problem of making a satisfactory application of safety appliances with particular reference to the relation of the side ladder, roof handhold and sill step.

Upon recommendation from that committee, the proposition to change the distance from the center of the truck to the end sill striking face, on house cars, from 5 ft. 0 in. to 5 ft. 6 in. was submitted to letter ballot of the members. This ballot resulted in a large majority vote in favor of this change as follows: in favor, 1,954 votes; against, 622 votes. The Committee on Car Construction has been instructed to retain the 5-ft. dimension, if possible, for open top cars.

Proposed Changes in Existing Tariff Regulations Covering Overloaded Freight Cars

The question of proposed changes in existing tariff regulations covering overloaded freight cars has been referred to a joint conference of representation of the Traffic, Transportation and Mechanical Divisions.

Postal Car Matters

The General Committee has appointed the following subcommittee to represent the Division in conferring with the Post Office Department on matters effecting Postal Car Specifications: C. E. Chambers (chairman), Central Railroad of New Jersey; F. H. Hardin, New York Central, and W. F. Kiesel, Jr., Pennsylvania.

Term of Chairman

After careful consideration and trial it is felt that the term of chairman of the division should be increased to two years to extend between the month of June of the even years. The chairman to be elected and installed in connection with the conventions held with exhibits. It is therefore recommended that Sections 7(a) and 7(b) of the Rules of Order be amended to read as follows:

Section 7 (a). The officers, except as otherwise provided herein, shall be elected at the regular meeting of the Division held in June of each even year and the election shall not be postponed except by unanimous consent.

Section 7 (b). The chairman and vice-chairman of the Division shall be elected by written or printed ballots each even year, the candidate receiving a majority of the votes cast shall be declared elected and shall hold office for two years or until their successor shall be elected.

Life Members

The following have been made life members of the Division during the year:

Date joined	Name	Title and railroad
1907	Dickinson, F. W.	M. C. B., Bessemer & Lake Erie.
1907	Diehr, C. F.	M. M., New York Central.
1907	Harris, C. M.	Vice-Pres., Hagerstown & Frederick.
1907	Henry, W. C. A.	Eng. of Motive Power, Pennsylvania.
1907	James, Chas.	Mech. Supt., Erie.
1907	Lamar, A.	M. M., Pennsylvania.
1905	MacRae, J. A.	(Retired) 901 Summit Av., Minneapolis, Minn.
1907	Mechling, J. E.	Spec. Insp., S. W. Region, Penna.
1907	Mengel, J. L.	M. M., Pennsylvania.
1907	Miller, E. B.	D. M. C. B., Baltimore & Ohio.
1907	Montgomary, H.	S. M. P. & R. S., Rutland.
1907	Oviatt, H. C.	Standard Stoker Co., Inc.
1907	Prendergast, A. P.	Mech. Supt., Texas & Pacific.
1907	Richardson, L. A.	G. S. M. P., C. R. I. & P.
1907	Rockfellow, W. E.	D. G. C. F. (Retired), N. Y. C.
1907	Seddon, C. W.	S. M. P., Duluth, Missabe & Northern.
1907	Selloy, S. H.	G. F. C. D., Boston & Albany.
1907	Shelaberger, J.	M. M., Southern Pacific.
1907	Sitterly, W. H.	G. C. I., Pennsylvania.
1907	Van Brimer, Geo.	Gen. Supt., Colorado & Wyoming.
1907	Wyman, R. L.	M. M., Lehigh & New England.
1912	Wallis, J. T.	Assistant Vice-President, Pennsylvania.

Obituaries

The secretary has been advised of the death of the following members during the year:

Name	Title and railroad	Died
Alquist, P.	M. C. B., D. L. & W.	May 4, 1927
Downing, I. S.	G. M. C. B., C. C. C. & St. L.	Jan. 15, 1927
Mackenzie, J.	2468 Arlington Rd., Cleveland, O.	Mar. 19, 1927
Parks, G. E.	M. E., Michigan Central	May 15, 1927
Umpleby, C. H.	M. M., New York Central	....

Nominating Committee

The committee recommends that no ballot be taken this year for members of the Committee on Nominations. The present committee is composed entirely of past presidents of the former Master Car Builders and Master Mechanics Association and past Chairman of the Mechanical Division. It is recommended that the present committee be continued.

The report is signed by L. K. Sillcox (chairman), Chicago, Milwaukee & St. Paul; G. E. Smart, Canadian National; C. E. Chambers, Central Railroad Company of New Jersey; C. F. Giles, Louisville & Nashville; E. B. Hall, Chicago & Northwestern; A. Kearney, Norfolk & Western; J. E. O'Brien, Seaboard Air Line; John Purcell, Atchison, Topeka & Santa Fe; J. S. Lentz, Lehigh Valley; J. A. Power, Southern Pacific Lines in Texas and Louisiana; O. S. Jackson, Union Pacific; F. H. Hardin, New York Central; A. R. Ayers, New York, Chicago & St. Louis; S. Zwight, Northern Pacific; A. G. Trumbull, Erie, and R. L. Kleine, Pennsylvania.

A motion was carried that the report of the General Committee be approved as a whole.

Report of Committee on Nominations

The terms of office of the chairman, vice-chairman and seven members of the General Committee expire June, 1927.

Section 7 (a) of the Rules of Order provides that officers of the division shall be elected at the regular meeting of the division held in June of each year. In view of the fact that the General Committee will recommend in its report a modification of this provision of the Rules of Order to provide for extending the term of officers to two years, to expire on the even year, and in order to make this fully effective in June, 1928, your committee nominates the following for the office of chairman and vice-chairman:

For chairman—Term expiring June, 1928: L. K. Sillcox, general superintendent motive power, Chicago, Milwaukee & St. Paul.

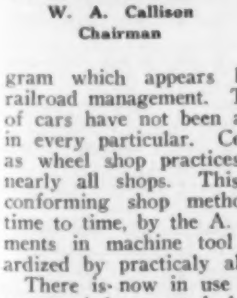
For vice-chairman—Term expiring June, 1928: G. E. Smart, chief of car equipment, Canadian National.

As the terms of seven members of the General Committee expire in June, 1927, your committee nominates the folowing to serve until June, 1929, as members of the General Committee: A. R. Ayers, assistant general manager, New York, Chicago & St. Louis; F. H. Hardin, assistant to president, New York Central; O. S. Jackson, superintendent motive power and machinery, Union Pacific; J. S. Lentz, master car builder, Lehigh Valley; J. A. Power, superintendent motive power and machinery, Southern Pacific Lines in Texas & Louisiana; A. G. Trumbull, chief mechanical engineer, Erie, and S. Zwight, general mechanical superintendent, Northern Pacific.

The report is signed by F. W. Brazier (chairman), New York Central; H. T. Bentley, Chicago & North Western; C. E. Chambers, Central Railroad of New Jersey; J. J. Hennessey, Chicago, Milwaukee & St. Paul, and John Purcell, Atchison, Topeka & Santa Fe.

On motion, the report was received.

Report on Design of Shops and Engine Terminals



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W. A. Callison
Chairman

The report which your committee submits this year is based upon a resolution that was passed at our 1926 convention, in connection with this committee's report to the convention, to-wit:

> (*Moved*)—the report of the Committee on Design of Shops and Engine Terminals be accepted and the committee be continued with instructions that consideration be given a system and a layout of shop that will insure a car being taken from revenue service in bad order, and returned to service in good condition in the least time and at the least cost.

The methods of repairing cars must vary necessarily to meet the different types of construction and, also, usually conform to a program which appears best to the shop supervision, or the railroad management. Therefore, shop methods in the repairing of cars have not been and probably never will be standardized in every particular. Certain details of repairs, however, such as wheel shop practices, follow the same general methods in nearly all shops. This has been brought about, largely, by conforming shop methods to meet the standards set, from time to time, by the A. R. A. Committee, and also by improvements in machine tool construction, which have been standardized by practicaly all builders of wheel shop machinery.

There is now in use a method of repairing cars which has commanded a great deal of attention in recent years, and that is the so-called "progressive system." This system has been mentioned in previous reports of this committee—in 1925 in connection with layout for a passenger car repair plant, and in 1926 when a layout for a freight car repair plant was submitted. The progresive system is now quite common in railroad shops throughout the country, but it is not operated in identically the same manner in all shops. To gain a better idea of how extensive the progressive system has been adopted, how it is operated on the several railroads, and of the results that are being obtained, the committee sent out a questionnaire to the principal railroads of the United States, and Canada. Replies were received from 64 railroads, owning 2,036,855 cars, or 75 per cent of the total number of cars owned by all of the railroads in these two countries.

The replies indicate a lively interest in the subject, and contain a great deal of information. We are giving below the questions asked, and following same a summary of the replies:

> 1—Do you use the progressive system in any of your car repair plants? If so, do you repair at one time a comparatively large number of cars of one series, or do you take in cars **regardless of series or class?**

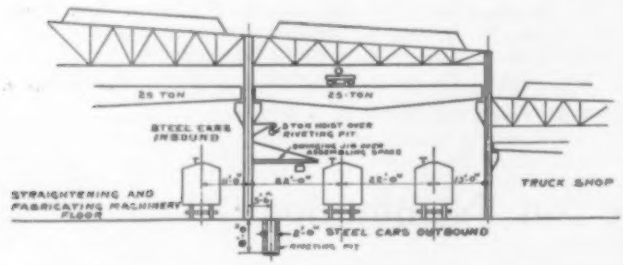
Replies indicate that of the 64 railroads answering the questionnaire, 28 railroads, representing 1,364,573 cars, stated they were using the progressive system in some form; while 36 roads owning 672,282 cars, stated they were not using such a system. Nearly all replies reported that to use the progressive system successfully it is necessary to take in cars by series—that is, to put through the shop at one time a considerable number of cars of the same general series, and in about the same general condition with respect to needed repairs.

2—If progressive repair system is used, advise:
(a) Class of repairs—heavy—extraordinary, probably involving betterments.
(b) Class of cars repaired—wood, steel composite.

A majority of the replies state that only heavy and, (or) extraordinary repairs are undertaken by the progressive system. Steel cars predominate in the total number of cars handled by this method; composite cars next in number; while comparatively few wood cars are repaired with the progressive system.

(c) Give program of moving car through shop, stating: Number of positions for each class of car worked; operations performed in each position; number of men in each position—mechanics, helpers and laborers, and time in minutes at each position.
(d) Show plan of shop for repairing cars as per (c) indicating size of building, track and machinery, layout, cranes and erecting runways, and other auxiliaries.
(e) Normal output different class of cars working one shift—8 hours.
(f) State method of wage payment—day work or piece work.

A review of the answers to these inquiries show that while practices in the several shops differ in detail yet there is more



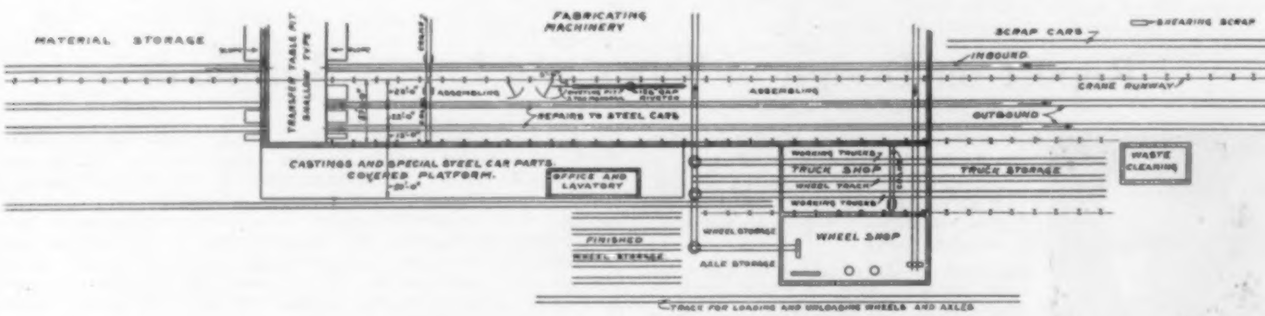
Cross-Section of the Supplemental Layout

or less uniformity in the method of moving the cars through the shop, and from the data submitted we are attempting to outline briefly below a program which is a sort of composite of all of the replies received.

Total number of positions—for all steel cars usually nine, and for composite or wood cars seven.

Position No. 1 *Stripping.*—Some shops make two "spots" in the "stripping position." The first for removing wood parts and the second for removing steel parts. Also other shops include in the stripping position a spot for sand blasting steel parts.

Position No. 2. *Repairing trucks.*—Some railroads repair trucks at this position, while same are at car. Other railroads



Supplemental Drawing to Car Shop Layout Shown in 1926 Report in Which Provision Has Been Made for a Gap Riveter and Riveting Pit in the Erecting Bay

remove the trucks and send them to a truck repair shop, and put the car through the shop on "dolly" trucks, and replace the repaired trucks under the car as it leaves the shop.

Position No. 3. *Repairing frames.*—In this position frames are straightened, and new members applied.

Position No. 4.—Applying steel siding and end sheets, fitting and bolting in place, and reaming holes.

Position No. 5. *Riveting.*—A separate riveting position is maintained by practically all of the railroads replying to the questionnaire.

Note: With composite and wood cars positions Nos. 4 and 5 are often omitted or work done at position No. 3.

Position No. 6.—Applying floors, siding, and all other parts below roof.

Position No. 7.—Applying roofs, running boards, and doors.

Position No. 8.—Applying airbrakes and safety appliances.

Position No. 9.—Painting and stenciling. On some railroads certain parts, such as siding and steel sheathing are given one or more coats of paint before being applied, and there is also a practice of having some parts painted on the repair track by second shift men after such parts have been applied by the first shift men.

Type of Shop Required for Progressive Repairs

3—Please criticize attached plan shown in A. R. A. shop committee report (p. 1570, *Daily Railway Age*, June 10, 1926), stating if same is applicable to your repairs, and if not, state and show in red pencil the alterations you would make, and support your reasons for such changes.

Only two railroads stated that this plan would not be satisfactory to meet their respective requirements. Nearly all railroads approve of the plan as a whole, with the reservation that some details may have to be changed to meet particular requirements. Following is a summary of principal criticisms, and the committee's reply to them:

Suggestions have been made by several roads that the plan should be modified as to size, to conform with number of cars to be handled. The arrangement in the plan submitted allows for a considerable variation in size without destroying the plan itself. Criticisms have been made by several roads that the tranesfer table should be eliminated, so as to operate the plant as a double-end shop with no return movement of cars through shop. The committee states that while there is merit in the through movement plan, yet the return movement layout has much to recommend it; for by the return through the shop the parts taken from a car during the stripping are repaired and picked up, and applied on the return trip, thus making a saving in labor of handling such parts. The double-end shop with through movement requires more ground for trackage, which may not be available. Since both plans have their respective merits, the choice is resolved down to one of space available and type and construction of cars to be repaired.

It has been mentioned by some roads that the fabricating shop is too large. It has been the observation of the committee during the inspection of a number of shops, that many do not have enough room in the fabricating department.

Criticism has been made that the fabricating shop should be outside of the main shop. This criticism has merit, but such an arrangement would mean transporting many parts from the stripping floor to the fabricating shop, for straightening and repairing, and returning them to the erecting floor.

In this connection it has been pointed out that there would be some difficulty in handling large parts from fabricating floor to the erecting floors, such as steel car sides and ends. To facilitate this latter operation the committee suggests locating a riveting pit in one erecting bay. In this arrangement sheets are handled by jib cranes from the fabricating floor to the riveting pit and complete sides and ends transported by the erecting bay crane to the car.

Several roads state that a separate truck shop is not necessary as they prefer to repair trucks at the position of the car. This does not interfere with the general plan or operation of the shop.

Exception has been taken to repairing wood and steel cars in the same shop. This practice is followed in nearly all shops at the present time as few roads have separate all steel and all wood shops.

Criticism has been made that the finished lumber shed should be on the opposite end of the planing mill, from that shown on the plan submitted. The best position for the finished lumber storage is that nearest the place where the lumber is used. On account of ground restrictions, this position is seldom attained;

however, if the ground space permits it would be more desirable to move the finished material shed nearer the shop, or reverse the position of this shed and dry kiln and lumber yard if this gives any advantage in a particular shop layout.

Conclusions and Recommendations

From the evidence submitted in the questionnaire, and from observations in shops, made by your committee, the following conclusions are drawn:

1—The progressive system has many advantages over the practice of taking cars into the shop as they come, regardless of series, class or kind of repairs needed.

2—The progressive system will reduce the cost of repairs as all material required for any operation can be handled in bulk to the point where the operation is performed.

3—The quality of the work performed will be improved due to the fact that each man will become a specialist on some particular operation.

4—The supervision required will be reduced and the output of any shop will be increased, other conditions being equal.

5—To operate the progressive system successfully necessitates shopping at one time, a large number of cars of the same series and requiring the same general class of repairs.

The committee recommends that when new car repair plants are to be constructed the submitted layout be given consideration with the view of operating on a progressive system, and the size to be determined by the requirements of the equipment owned by the railroad.

The committee also recommends that when extensions to car repair facilities are needed on any railroad study be given to the existing car repair plants to determine if they can be rearranged as to trackage, buildings, etc., to operate on a progressive system.

The report is signed by W. A. Callison (chairman), Chicago, Indianapolis & Louisville; J. M. Henry, Pennsylvania; B. P. Phelps, Atchison, Topeka & Santa Fe; J. A. Brossart, Cleveland, Cincinnati, Chicago & St. Louis; J. Burns, Canadian Pacific, and George F. Hess, Wabash.

Discussion

L. Richardson (B. & M.): Some twenty years ago there was quite a discussion between the advocates of the longitudinal and transverse type of locomotive shops and they were somewhat evenly divided. Today it is all transverse. The Southern changed over at Birmingham, the Union Pacific at Cheyenne, and the Pennsylvania at Altoona. There are some individual plants operating on a semi-transverse system. I regret very much that the committee has not covered that phase, because I feel that eventually the transverse type of progressive car shop is going to stand on a par with the longitudinal shop.

C. E. Chambers (C. N. J.): I am heartily in accord with the double-end shop. It has many advantages over a reverse movement. It is true that the ground is not probably always going to be what you like, but it would be extremely advantageous to the railroad companies to get the ground and then put the shop on it. By having a continuous movement through the shop, there are many advantages, like passing out through the sand-blast building, paint shops, and then stencilling, and through a lead track where the cars are moved over the scale, which is the last thing to do before they are turned over to the transportation service.

G. E. Smart (C. N.): In the Montreal plant of the Canadian National, you will find cars being repaired under the progressive system. It is a single-ended shop, an old shop, but now our plans are prepared to have a modern shop. We are limited as to space, and will have to build a single-end shop. That is the determining factor in many cases, although there are points against the double-end and single-end shops.

We have another shop in Toronto which the motive power department of the Canadian National, unfortunately, had no use for, but, fortunately for the car department, we have made use of that as a steel car repair shop. We are repairing in that shop on the progressive system. It was laid out with a transfer table and with the bays similar to what you would see in a locomotive shop. We have had to adapt the method of repairs to the type of a shop.

I am in favor of the progressive system of repair. But we have got to give careful study to it. You have got to select and repair your cars in series.

G. F. Hess (Wabash): As far as locomotive shops are concerned, I have always been in favor of the transverse type. When I went to the Wabash the main shop was longitudinal and it was practically up-to-date at that time. It has since been changed, and now we have a transverse shop. The new shop was put in operation in February. Since that time we have had a tornado which has taken the roof off and the west side of the new shop out, so we have not really gotten started yet.

Mr. Smart: We have been invited to visit the Canadian Pacific shops. The locomotive shop is of longitudinal design. You will find a modern freight car shop, longitudinal, and the passenger shop, transverse. On the Canadian National, we have both transverse and longitudinal locomotive and passenger car shops.

The new layout that we have prepared and which we are starting this year at Montreal, will have a transverse locomotive shop, a longitudinal freight car shop, and a transverse passenger car shop, with transfer table between shops on either side.

J. J. Tatum (B. & O.): We have some modern locomotive shops on our road that we feel proud of. Our car shops are of the old type in which the new system has been worked, beginning about 1920. To the present time, we have rebuilt with the progressive method about 90,000 cars. We have built new bodies for about 8,000 cars which included all-steel hopper cars, both of 50,000 and 70,000-lb. capacity. We have also built our new all-steel underframe caboose cars.

For a number of years I thought it was necessary that we have a new freight car shop somewhere. Many plans had been drawn. Some of them represented an expenditure of two or three million dollars. During the period of heavy equipment rehabilitation with these inadequate shops, we had to call on contracting shops to repair or rebuild about 10,000 cars a year. But fortunately, with the spot system we have discarded a number of our shops because we have no use for them; we have built no new shop because we don't need it; we have maintained our equipment in B. & O. shops with B. & O. men, and we believe that we have repaired our equipment as cheaply as any other railroad. We know that we have repaired it more cheaply than in the past. If it were necessary to build a new shop I would recommend that we build a double-end shop, because that is best for the spot system. Perhaps some wooden cars or steel underframe cars may become in a condition to need rebuilding about the same time steel cars of all-steel construction require rebuilding. We have about 15 points where the spot system is carried on. We allow one or more weeks for one class of car to accumulate. While that happens we are repairing another class of cars. During that period the man in charge of the shop finds the material needed to repair the group of cars he is assembling, and by the time that he has a reasonable number available to take up at least one week's work of a unit of organization, he has the material ready and the cars pass through without any delay.

The progressive method of repairing cars is reducing the cost of maintenance. It is just as easy to rebuild and repair locomotives on the spot system as it is the cars on the spot system.

On motion the report was received.

Report on Couplers and Draft Gears

R. L. Kleine
Chairman

Believing that a brief account of the status of the A. R. A. draft gear tests will be of interest, the following progress report is submitted. Our report of last year mentioned the fact that it had been decided by the General Committee that the drop test machine was to be located at Purdue University, Lafayette, Indiana, and that the order for the drop test machine had been placed with the Tinius Olsen Testing Machine Company.

The final shipment of parts of the drop test machine was made in April and the erection in the building provided for the purpose, as well as the installation of the electrical mechanism, wiring, etc,. is under way.

The building, is 25 ft. by 50 ft., of brick construction, architecturally in harmony with the University buildings, and being used solely for draft gear testing, was designed with that end in view.

The draft gear testing machine is equipped with two tups, one weighing 9,000 lb. and the other 27,000 lb., both of which will be used in the tests. The former will be used in obtaining the recoil of the draft gears and also the capacity and other characteristics of a portion of the draft gears of each design in order that if desired, comparisons may be made with tests made elsewhere, as generally speaking a 9,000-lb. tup has been used. The 27,000-lb. tup has the advantage of a lower velocity at moment of impact than the 9,000-lb. tup when delivering a blow of a given number of foot-pounds and more nearly approaches the speed of cars when being coupled and for this reason it will be used throughout the tests, except as previously referred to.

The moveable guides which are secured to the main columns permit the substitution of one tup for the other with a minimum amount of labor, and without dismantling the columns. The machine is electrically operated, and so designed that in addition to complete manual control, certain functions that permit of such arrangement are semi-automatic. A chronograph is provided for recording the action of the draft gear being tested throughout the cycle of compression and release.

From the data obtained in connection with these tests, the following information and characteristics of the draft gears will be available: Capacity, recoil, sturdiness, endurance, smoothness of action, cushioning value, and uniformity of product, and based upon these results, specifications will be prepared under which, when approved by the asociation, the railroads may purchase draft gears that are known to meet the required standards of efficiency.

After working out the proposed methods to be followed in testing draft gears, the plans were submitted to the manufacturers for the benefit of their suggestions and criticisms, all of which were carefully considered, and where favorably thought of, embodied in the proposed method of conducting the tests.

It is expected that the draft gear tests will be started during the latter part of May and that approximately two years will be required for their completion. The draft gear tests will be conducted under the supervision of your committee and will be in charge of Dean A. A. Potter of the Schools of Engineering and director of the Purdue Engineering Experiment Station and W. E. Gray, engineer of draft gear testing. All of those actually engaged in the testing work will be in the employ of the University.

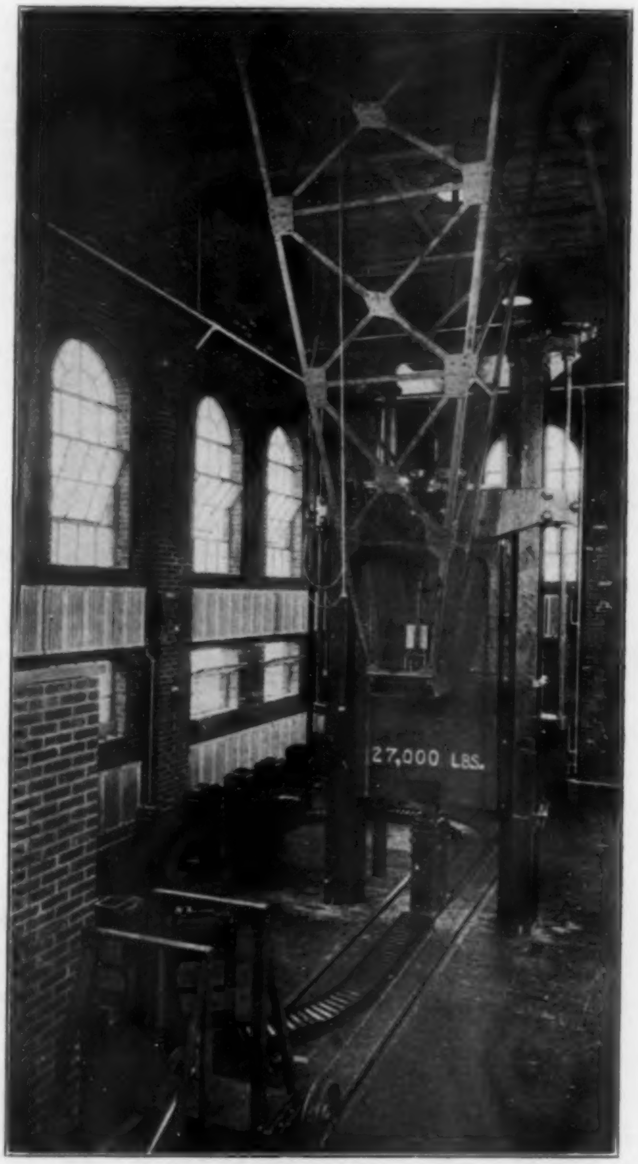
The interest taken by draft gear manufacturers in developing their products is indicated by the improvements in detail design as well as new designs, some embodying entirely new principles that have been brought out within a comparatively recent date. In addition to the information on draft gear performance that will be available as a result of the A. R. A. tests and the benefits that may be expected from the adoption of specifications for draft gears, it is hoped that the testing machine will be of great assistance in improving design and in developing experimental gears.

Under the terms of agreement with Purdue University, manufacturers of draft gears desiring tests or other research work on the A. R. A. draft gear testing machine may have such work undertaken when the testing machine is not engaged in A. R. A. work by making suitable arrangements with the Purdue University authorities. It is felt that the opportunity thus offered the manufacturers will be helpful in the further development of this important detail of cars and locomotives.

The report is signed by R. L. Kleine (chairman), Pennsylvania Railroad; C. P. Van Gundy, Baltimore & Ohio; C. J. Scudder, Delaware, Lackawanna & Western; H. W. Coddington, Norfolk & Western; C. B. Young, Chicago, Burlington & Quincy; Samuel Lynn, Pittsburgh & Lake Erie; L. P. Michael, Chicago & North Western; E. A. Gilbert, Southern Pacific; and M. A. Hall, Kansas City Southern.

Discussion

R. L. Kleine (Penna.): In visiting the draft gear test, it is thought that it would not be advisable to have the members go there promiscuously, as that will interfere with the work of the men conducting the tests. It was thought better to set aside a number of days and issue a circular to the members asking them to come out. During those days no official tests will be made.



A. R. A. Draft Gear Testing Machine in Special Laboratory at Purdue University

The committee has agreed upon the following instructions relative to the visiting of the draft gear tests. In conducting the tests the committee agreed to give out no information whatever. Members of the committee and the sub-committee may come to Lafayette and see the

tests, but manufacturers will be excluded from them. When the tests are completed, the draft gear committee will report on the tests to the association, which will then make public the results.

It was decided that when the machine is installed and in working condition, that Dean Potter fix a date and that the secretary of the association will write all draft gear manufacturers to visit the testing plant and look over the machinery, but when the official tests are in progress that no manufacturers or their representatives will be permitted in the testing room. The members of the draft gear committee are welcome to visit the testing room at any and all times.

The tests themselves will be under the jurisdiction of a sub-committee. They have laid out all the details of these tests, which have been submitted to the manufacturers and their criticisms asked for, and such criticisms adopted as the committee thought were essential. The members of the sub-committee are: W. C. A. Henry (chairman), Penna.; H. M. Foss, N. Y. C.; H. W. Coddington, N. & W.; H. I. Garcelon, B. & O., and C.

On motion the report was received.

Report on Specifications and Tests for Materials

F. M. Waring
Chairman

This report covers the work during the past year that has been brought to a conclusion. Other subjects on which no final decision has been reached, but which are being actively pursued, are:

Carbon vanadium steel forgings,
Springs,
Chain,
Copper tubing,
Malleable iron castings,
Non metallic inclusions in steel for forgings and castings,
Gas and oxygen hose,
Lumber, in collaboration with committee on Car Construction.

The committee recommends that the following be submitted to letter ballot for approval.

Revision of Standard Specifications

Specifications for air brake hose gaskets: These specifications have been revised to include sketch of gasket and table of tolerances as revised by the committee on Brakes and Brake Equipment in their 1926 report. (See Daily *Railway Age*, June 12, 1926.)

Specifications for Air Brake Hose Gaskets

Change Sec. 7 to read:

7. *Dimensions.*—All gaskets shall conform to the nominal dimensions and tolerance shown in Fig. 1. All gaskets shall be uniform in size and section.

Fig. 1 to be revised.

Revision of Recommended Practice Specifications

(a) In the specifications for wrapped air hose, braided air hose, steam hose, and wrapped cold water hose, the pressure tests have been changed from a momentary maximum to a lower pressure held for 10 minutes. It is believed that this holding test is of more value for developing defects in the hose. Also standard inspection and rejection clauses have been added to the above specifications.

(b) In Specifications for fire hose and tender tank hose, standard inspection and rejection clauses have been added.

(A) 1—Specifications for Wrapped Air Hose

Change Sec. 12 to read:

12. *Hydrostatic Test*—The remainder of the 2 ft. sample after all other test pieces have been cut therefrom shall withstand a hydrostatic pressure test, as follows, for a period of 10 minutes without bursting or developing defects:

Inside dia. of hose, in.	Pressure, lb. per sq. in.
⅜, 7/16, ½, ¾, 1	625
1¼, 1½	550

2—Specifications for Braided Air Hose

Change Sec. 12 to read:

12. *Hydrostatic Test*—The remainder of the 2 ft. sample after all other test pieces have been cut therefrom shall withstand a hydrostatic pressure test, as follows, for a period of 10 minutes without bursting or developing defects:

Inside dia. of hose, in.	Pressure, lb. per sq. in.
⅜	600
7/16	600
½	700
¾	625
1	550
1⅛	450
1½	375

3—Specifications for Steam Hose

Change Sec. 12 to read:

12. *Hydrostatic Test*—One of the 24 in. test samples shall withstand a hydrostatic pressure test, as follows, for a period of 10 minutes without bursting or developing defects:

Inside dia. of hose, in.	Pressure, lb. per sq. in.
⅜, ½, ¾, 1	700
1¼, 1½	650
1⅝, 1¾	625

4—Specifications for Wrapped Cold Water Hose

Change Sec. 11 to read:

11. *Hydrostatic Test*—The remainder of the 2 ft. sample after all other test pieces have been cut therefrom shall withstand a hydrostatic pressure test, as follows, for a period of 10 minutes without bursting or developing defects:

Inside dia. of hose, in.	Pressure, lb. per sq. in.
½, ¾, 1, 1¼, 1½	350
2, 2¼, 2½	300
3	250
3½, 4	200

All of the above specifications are to have inspection and rejection clauses added, suitably numbered, as follows:

Inspection and Rejection

17. *Inspection*—(a) The manufacturer shall notify the purchaser sufficiently in advance of the completion of the hose to permit of arrangement for inspection.

(b) The manufacturer shall afford the inspector, free of charge, all reasonable facilities to satisfy him that the hose is being furnished in accordance with these specifications. Tests and inspection at the place of manufacture shall be made prior to shipment.

(c) The purchaser may make the tests to govern the acceptance or rejection of the hose in his own laboratory or elsewhere. Such tests shall be made within 60 days after date of shipment and at the expense of the purchaser.

17. *Rejection*—In case of failure to pass any of the tests or requirements of these specifications, the entire lot of hose represented by the sample or samples shall be rejected. Each length of hose which fails to meet any of the requirements of these specifications shall be rejected.

18. *Rejected Sample*—Samples of rejected hose shall be preserved for two weeks from the date of the test report.

(B) Specifications for Fire Hose, and Specifications for Tender Tank Hose

Inspection and rejection clauses, suitably numbered, to be added to these specifications, reading the same as given above.

New Recommended Practice Specification

A new specification for Liquid Paint Drier to be used with linseed oil in freight car paints is shown. The present specifications for Japan drier are to be used with paint reducing oil and unless there is some demand for their retention the committee will probably recommend in its next report that they be dropped from the Manual.

Specifications for Liquid Paint Drier

1. *Scope*—These specifications cover liquid paint drier to be used in conjunction with linseed oil in mixing paint to proper consistency for painting freight equipment cars.

2. *Composition*—The drier shall be composed of lead, manganese or cobalt, or a mixture of any of these elements combined with a suitable fatty oil, with or without resins or "gums," and mineral spirits or turpentine, or a mixture of these solvents.

I. Physical Properties and Tests

3. *Physical Properties*—(a) Appearance: The drier shall be free from sediment and suspended matter.

(b) Color: The drier when mixed with pure raw linseed oil in the proportions of one volume of drier to eight volumes of oil, the resulting mixture shall be no darker than a solution of 6 g. of potassium dichromate in 100 cc. of pure sulphuric acid of specific gravity 1.84.

(c) Flash Point: The flash point shall not be lower than 85 deg. F. when tested in a "Tag" closed-cup tester.

(d) Miscibility Test—The drier shall mix with pure raw linseed oil in

the proportions of one volume of drier to 19 volumes of oil without curdling, and no sediment or precipitate should appear in the mixture on standing for two hours.

(e) Elasticity Test—The drier when flowed on a piece of bright sheet metal previously cleaned with benzol, allowed to stand in a vertical position at room temperature for 30 minutes, then hung in an oven and baked for two hours at 212 deg. F. shall leave an elastic film.

4. *Drying Test*—The drier when mixed with pure raw linseed oil in the proportions of one volume of drier to 19 volumes of oil, the resulting mixture when flowed on a glass plate, and placed in a vertical position in a well ventilated room, shall dry in not more than 18 hours.

II. PACKING AND MARKING

5. *Packing*—Liquid paint drier shall be put in moisture-proof harrels, cans or packages, according to the railroad company's requirements.

6. *Marking*—The manufacturer shall mark the packages according to the railroad company's requirements.

III. INSPECTION AND REJECTION

7. *Inspection*—(a) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications.

(b) The purchaser may make the tests and inspection to govern the acceptance or rejection of the material in his own laboratory or elsewhere. Such tests and inspection shall be made at the expense of the purchaser.

8. *Rejection*—Liquid paint drier represented by samples which fail to conform to the requirements of these specifications will be rejected.

9. *Rejected Sample*—Samples tested in accordance with this specification, which represent rejected material, shall be preserved for fourteen days from the date of test report.

The report is signed by F. M. Waring (chairman), Pennsylvania; H. D. Browne, Chicago & North Western; H. G. Burnham, Northern Pacific; E. E. Chapman, Atchison, Topeka & Santa Fe; H. W. Faus, New York Central; A. H. Fetters, Union Pacific; J. H. Gibboney, Norfolk & Western; G. N. Prentiss, Chicago, Milwaukee & St. Paul; F. T. Quinlan, New York, New Haven & Hartford; J. C. Ramage, Southern Railway; T. D. Sedwick, Chicago, Rock Island & Pacific; C. P. Van Gundy, Baltimore & Ohio and Frank Zeleny, Chicago, Burlington & Quincy.

Discussion

W. A. Pownall (Wabash): Has the committee found any way of using this drier with linseed oil with freight car paint; that is, a drier of this nature?

F. M. Waring (Penna.): I can't answer that question unless Dr. Gibboney or some of the paint experts of the committee are here. That specification was put forward as something that had been used on several of the large roads and found to be entirely satisfactory. It is suggested that it should be broadcast to the members of this association with the view of having them try it and advise the committee whether, in their opinion, it could be adopted as a permanent specification.

It was moved and seconded that the report be referred to a letter ballot. The motion was carried.

Report on Brakes and Brake Equipment

G. H. Wood
Chairman

The committee has the following to submit for consideration:

Freight Car Retaining Valve

Your committee recommends a modification in the specifications submitted on page 5 of last year's report covering the standard freight car retaining valve. Change the last four lines to read:

With 8 in. piston travel or a volume of 640 cu. in., from 55 lbs. to 25 lbs. in 81 to 99 sec. when in high pressure position, and from 45 to 55 sec. when in low pressure position, should be used.

This changes the blow down time in high pressure position, which is at present specified as 85 to 95 sec. The change is requested in order that the same time tolerance will be provided for the high and low pressure valves, and to reduce the cost of manufacture and maintenance.

Air Brake Hose Couplings and Nipples

Some variation has been found in dimensions of air brake hose nipples, and we believe a specification for dimensions is warranted; means should also be provided to identify hose couplings manufactured in accordance with gages adopted last year, and to this end recommend the adoption of the drawing covering these features.

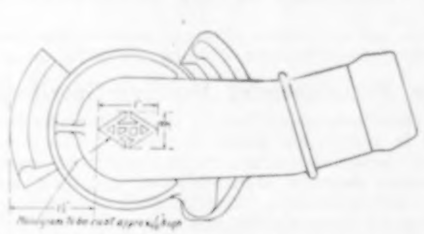


Fig. 1—Location of Designating Monogram on Air Brake Hose Couplings Made to A. R. A. Standard Gages

One-Half Inch Common Nut for Triple Valve Bolts

Triple valve bolts received from the manufacturers are equipped with the A. R. A. standard ½-in. finished nut; however, it is the practice of the railroads to substitute the common ½-in. nut in making repairs. Your committee has been requested to recommend the ½-in. common nut as standard for triple valve bolts to avoid the necessity of repairmen using two wrenches. We have investigated and find that not enough care is used in the manufacture of the common cold punched nut, and that difficulty in variation of sizes as between the finished nut and common nut would not be overcome by the general use of the common nut. The committee calls attention to this, urging more care on the part of repair points in maintaining the ½-in. finished nut in triple valve repairs.

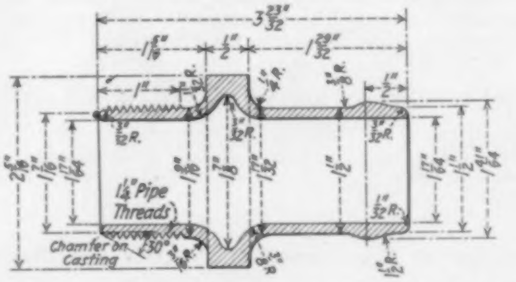


Fig. 2—Proposed Standard A. R. A. Hose Nipple, 1⅜ in. by 1¼ in.

Single Car Brake Testing Device

The committee has been requested to specify a single car testing device for testing brake equipment on freight cars in accordance with A. R. A. Maintenance Rules 101 and 102 as adopted in 1925. For the purpose two types of testing devices are shown, either of which will meet requirements. Heretofore various devices have been employed, some of them being far from satisfactory. The testing device, Figure 3, is finding favor on many roads. We would recommend the adoption of single-car testing devices as shown in Figs. 3 and 4, leaving it optional as to which particular device may be used.

Triple Valve Test Racks

We have also considered a suggestion to require the use of a leakage indicator in connection with the present standard A. R. A. triple valve test rack. Many of these devices are in use on a number of roads and are apparently proving satisfactory, inasmuch as they provide for more uniform regulation of slide valve leakage, elimination of excess leakage due to poor judgment in the use of soap-suds, definite limitations of slide valve leakage, reduced compressor labor on account of lessened brake system leakage, less liability of brake cylinder pressure equalizing that of the auxiliary reservoir on partial service brake applications. This question has been considered in connection with

a suggestion to prohibit the use of the 2-T test rack for testing freight triple valves. The committee agrees that there might be some merit in the latter suggestion although we recognize the fact that there are a considerable number of 2-T test racks still in service. We will attempt to learn to what extent the 2-T racks are still in use and may later recommend some action looking toward the elimination of this type and standardizing on the 3-T type; in which event the leakage indicator will be considered in connection with this recommendation.

Tolerances for Camber of Brake Beams

There has been some question regarding the proper camber of brake beams, the present recommended practice beam showing

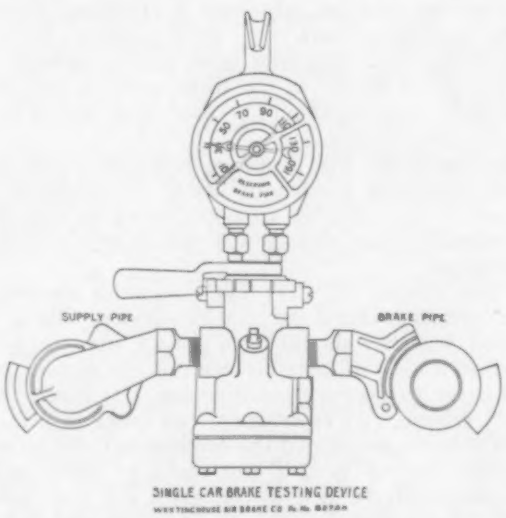


Fig. 3—Westinghouse Single-Car Brake Testing Device

no tolerance for this measurement. In investigating we find that a variation in the camber in a brake beam within reasonable limits will in no way affect the strength or service of the beam. Brake beams have been built with camber as low as ¼ in. and as high as 2⅝ in. to meet the varying truck and brake beam clearance conditions, and all are giving satisfactory service.

It has been suggested that a tolerance of ⅛ in. plus or minus be provided for brake beam camber. In view, however, of the wide variation in beams now in service we feel that more consideration should be given the subject before recommending any change, as this might affect beams which are giving satisfactory results in service and bring about unnecessary expense. This matter will, therefore, be given further consideration.

Methods of Avoiding Slid Flat Wheels

Under subjects for discussion the committee was given the subject of Methods of Avoiding Slid Flat Wheels, the question to be covered as a special item. A paper dealing with the subject has therefore been prepared for your consideration. This follows.

On account of the limited time available for gathering data, we have been unable to develop the generally accepted methods in vogue or any particularly new methods which might be more advantageous in avoiding slid flat wheels; therefore, what follows is based upon experience upon the lines represented by the members of the committee.

Obviously, adequate maintenance of brake equipment is necessary if proper brake performance commensurate with operating conditions is to be expected. As a means of providing for adequate maintenance of brakes, we refer you to the present A. R. A. Maintenance of Brake and Train Air Signal Equipment Rules. A proper compliance therewith, both for cars and locomotives, will, we feel, avoid, as far as possible, slid flat wheels which might be contributed to by methods of maintenance which are less rigid in their requirements. It is of the utmost importance that the brake system be as free from leakage as possible in

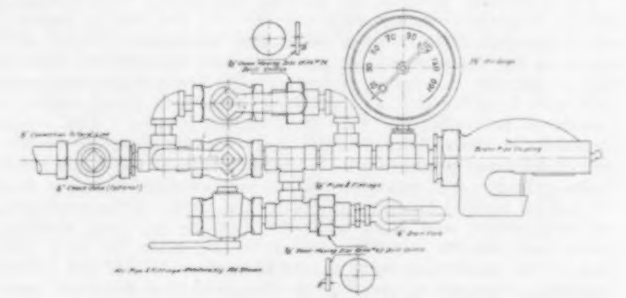


Fig. 4—General Arrangement of Single-Car Brake Testing Device

order that brakes having once been applied may, under proper methods of manipulation by the engineer, be released. The present A. R. A. Rules contemplate a maximum of 7 lb. per minute brake pipe leakage; however, this leakage should be maintained to a lesser degree insofar as possible. This, we feel, can best be cared for by a proper installation of pipe and fittings which are suitably and substantially clamped in position to prevent shifting and vibration, and by eliminating leakage from the brake system when cars are on regularly designated repair tracks or on other tracks where men and facilities are available for making suitable tests and repairs.

Care should be exercised in designing foundation brake gear to provide ample clearance and freedom of movement for all brake rods, levers, beams, etc., and that the angle of brake rods be as nearly as possible within the lines of force acting through their various connections. Brake beam hangers should be of proper length and position between their fulcrum point and the brake head to prevent increases in force on the brake shoe due to a wedging or togging effect, and we suggest the application of clasp type brake gear where conditions permit.

The committee has made no attempt to deal with this subject by outlining a detailed policy of instruction on manipulation or maintenance as we believe practically all roads have provided

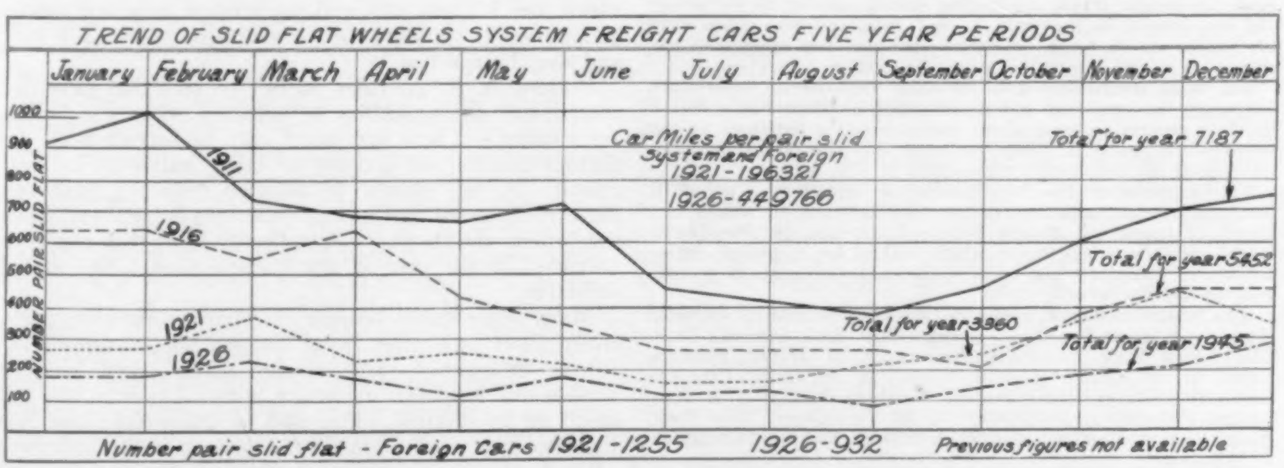


Fig. 5—Reduction in Slid Flat Wheels Obtained Through Method of Checking Outlined in Committee Report

rules covering these features, but wish to call attention to a policy of checking and accounting which we think would justify consideration where such method is not the practice and the number of flat wheels occurring seems to be excessive.

The causes for wheel sliding are numerous and the conditions under which they occur are such that it is impossible, in all cases, for those supervising train operation to determine definitely the exact cause or circumstance under which they occur. Investigation will develop that on 50 per cent or more of cars having flat wheels tests of the brake equipment do not disclose defects which contribute to this damage. It is apparent from this that in ordinary operation many wheels are slid flat due to unavoidable causes or improper handling of equipments by trainmen and enginemen. The problem is one that the mechanical department cannot alone successfully cope with; it is necessary, therefore, that they have the continued co-operation of the operating department if the cost and delay incident to slid flat wheels is to be maintained at a minimum consistent with the operating conditions on any railway.

The following practice, we believe, approaches closely such a policy: Reports covering each case of slid flat wheels removed are forwarded directly to a designated mechanical officer with copies to the division master mechanic and trainmaster, this report to indicate the result of tests of the brake equipment upon such cars in order that any defective conditions found might be considered in connection with contributing causes. The report should show brake lever measurements for the complete foundation brake gear in addition to a complete test of the triple valve, brake cylinder and retaining valve, the previous cleaning date, the engine number handling the train, the name of the conductor, and engineman, and from what division the car was received. From such reports monthly summaries are made for each division of the system showing the total number of slid flat wheels removed compared to previous periods, and also the total number of cases chargeable to defective brake equipments such as triple valves, retainers or foundation brake gear. These summaries are reported monthly, quarterly, semi-annually, and annually, copies of the reports being forwarded to the general transportation and mechanical officers, such as general managers and superintendents of motive power, and also all local division transportation and mechanical officers, including the trainmasters, road foremen of engines, and car foremen.

These reports are scrutinized regularly by the general officers who call upon the local division officers for explanations regarding increases in wheel damage or where there appears to be an excessive number of slid flat wheels occurring over other divisions having similar operating conditions. The local division officers investigate cases of slid flat wheels as indicated by the reports rendered when the wheels are removed, calling the trainmen and enginemen to account for those cases which happened while the train was in their charge. Conductors are required to report flat wheels on cars picked up en route or which are in their trains when leaving initial stations. Inspection must be made as freight trains are leaving initial stations to check for slid flat wheels in the train at that time, and also when cars are picked up en route, otherwise trainmen and enginemen are charged with the responsibility for the damage occurring.

The local mechanical and operating department supervisors follow up the operating and maintenance conditions as reflected by these reports to bring about such corrective measures as are possible and practical. The results of this method having been established are graphically represented in Fig. 50.

This improvement has been continuous throughout a period of increasing weight and tractive force of locomotives, weight and length of trains and greatly increased car mileage. Possibly it is the predominating factor which makes for improved maintenance of equipment and train operation to bring about prevention of slid flat wheels.

This report is signed by G. H. Wood (chairman), Atchison, Topeka & Santa Fe; T. L. Burton, New York Central; B. P. Flory, New York, Ontario & Western; J. M. Henry, Pennsylvania; M. A. Kinney, Hocking Valley; W. H. Clegg, Canadian National Railways; Mark Purcell, Northern Pacific; R. B. Rasbridge, Philadelphia & Reading; G. E. Terwilliger, New York, New Haven & Hartford, and W. J. O'Neill, Denver, Rio Grande & Western.

Discussion

G. H. Wood (A. T. & S. F.): We have ever since the inception of the spring type retaining valve had some difficulty in preventing the distortion of springs, and the application of improper springs, and troubles of that kind. It has seemed almost impossible to overcome the trouble from that source, and we have asked the air brake company to redesign the cap so that the spring might be contained in a barrel which would be a part of the cap, so that it could not be gotten at so readily, and a different kind of a spring would be used.

The air brake company has been working on that, and think they have or will have within a short time a cap that will get us away from the trouble we have been having with springs, and for that reason, it is possible that when we get this changed cap and spring that a different kind of tolerance will be necessary than that which we were about to ask for.

For that reason we wish to substitute for the first item in our paper the following:

As a substitute for the specification in our report a year ago, we wish to substitute a retaining valve for freight equipment cars. A three-position 10-20 lb., duplex spring type retaining valve having nominal blow down values of 50 sec. in the 10-lb. position and 90 sec. in the 20-lb. position should be used with both 8 in. and 10 in. brake cylinders.

That means we will have one retaining valve for all freight equipment instead of about 15 which we now have and it will give us an opportunity to recommend final tolerances for blow-downs which won't need further change.

E. Von Bergen (I. C.): The committee's recommendation covering single car testing devices fills a long-felt need, but they should have gone a step further and prescribed a code of tests for each of the devices, which would cover (a) service sensitiveness, (b) service stability, (c) release, (d) emergency, (e) brake pipe leakage.

It is to be regretted that the committee failed to recommend that the use of 2-T test racks be prohibited. It costs comparatively little to convert a 2-T test rack into a 3-T. Certain undesirable features of the 2-T rack impelled the air brake companies to bring out the 3-T rack several years ago. It is a well-known fact that the soap bubble test used in the absence of a leakage indicator, is of exceedingly little value. This can be easily proved by applying the leakage indicator test to triple valves that have passed the soap bubble test. It will be found that approximately 75 per cent of the valves that would have gone into service in a more or less defective condition will be caught by the leakage indicator. For the sake of a uniform standard of triple valve maintenance, the 3-T test rack and the leakage indicator should be adopted as standard, to the exclusion of the 2-T rack and soap bubble test.

Present A. R. A. rules do not require that defective centrifugal dirt collectors be repaired when the brakes are cleaned. There are many cars in service with deflectors missing on account of being eaten up by corrosion. A rule should be adopted requiring that any defective internal part of dirt collectors be renewed when the brakes are cleaned. A deflector stem that has been corroded 25 per cent at any portion should be counted defective.

Many triple valves become defective within a comparatively short time after being cleaned on account of defective emergency valve rubber seats. Any kind of rubber that has been in service 9 to 12 months has lost much of its original value, and as these seats cost less than two cents each, it is absurd to leave to the judgment of a repair man's visual inspection the question of whether it is good for another twelve months' service. The maintenance rules should require that the rubber seat be renewed each time a triple valve is cleaned.

Freight triple valves now reach repair rooms equipped with three different kinds of cylinder cap and check case nuts, viz: manufacturers' standard or special-faced nuts, U. S. cold-punched nuts, and hot-pressed nuts. Aside from these, there are thousands the surface of which has been spoiled by the use of a chisel or poor fitting

wrench. The hot-pressed nut is of very poor quality, and its use should be prohibited. It has been found on one road that it is practically cheaper to throw away the old nuts and apply U. S. S. ½ inch cold-punched nuts than to stand the labor waste of trying first one wrench then another to fit the various sizes so frequently found on one triple valve. The manufacturers' standard nut furnished by the air brake companies has the same size thread, but a different diameter across flats from the U. S. S. cold-punched nut. The manufacturers' standard faced nuts cost 1.56 cents each; the U. S. S. .67 of a cent each.

There are approximately 2,542,538 triple valves in service on the freight cars on the railroads of the United States and Canada. Assuming that they will average being dismantled once each nine months for cleaning or repairs, there are approximately 15,890,862 cylinder cap and check case nuts removed and re-applied per year, representing an enormous labor waste on account of the varying sizes and condition of the nuts handled. Assuming the life of these nuts as averaging two years on account of corrosion, the use of poorly fitting wrenches, or chisels, there are required for renewal 7,945,431 nuts per year. The difference in cost of the manufacturers' standard as compared with the U. S. S. cold-punched nuts therefore amounts to an additional expenditure of $70.714.33 per year.

The committee has stated that the air brake manufacturers use an A. R. A. standard ½ inch hexagon finished nut, and that not enough care is used in the manufacture of the cold-punched nut; therefore, they prefer the application of the nut used by the air brake companies. The definition of a finished nut is one that is finished all over and the nut used by the air brake companies is not finished all over. It appears to be a cold-punched nut faced on the bottom and with dimensions across flats 1/16 inch less than the U. S. S. nut.

I have available here samples of both kinds of nuts, just as they came from the manufacturer, and I invite anyone to show why it is necessary to go to the added expense of facing a nut that is only used to draw two castings together with a gasket between, and also why the U. S. S. cold-punched nut will not do the job as well as the special nut furnished by the air brake companies. In fact, it will do a better job as there are more threads to engage the bolt.

Aside from the expense above referred to, additional investment is incurred to carry the special nuts in stock, whereas the U. S. S. cold-punched nut is usually carried in stock by all railroads. I submit that the U. S. S. ½ inch cold-punched nut should be adopted as standard for freight triple valves, by the A. R. A., and the air brake companies be required to furnish it on new triple valves. Or if it is desired to spend the additional money for special-faced nuts, that these should be specified as standard for this purpose, and the finding of any other nut, or one dented with a chisel or other tool, on a cleaned or repaired triple valve, should be sufficient cause to cancel the bill for cleaning brakes on that car.

Mr. Wood: Before the Committee recommended retaining the standard nut as furnished by the air brake company, we got some of the common cold-punched nuts and we found that the relief that Mr. Von Bergen was seeking would not be obtained by using the common cold-punched nut as is furnished at the present time generally. Some of these cold-punched nuts when they are put in the machine are not chucked square, and the tap goes through them at almost any angle that the nut happens to get in the chuck. If the joint is pulled up tight they will either bend the bolt or strip the threads. There is a wrench for the standard nut as furnished by the air brake company for the common cold-punched nuts. Some of these cold-punched nuts will drop out of sight down in the bottom of this wrench, others won't go in it at all. If we make that wrench big enough in the beginning to take the common cold-punched nut as it comes to us and we find that we have got to pull up tight we will either bend the bolt or strip the thread. We are going to take the corners off the nut too. Either the wrench is no good or the nuts are no good. The committee considered very carefully Mr. Von Bergen's suggestion to see if there was enough saving in changing from one nut to the other. As a matter of fact, it does not make any difference whether you adopt the common cold-punched nut or whether you adopt the finished nut or the semi-finished nut, because you are going to find any kind of a ½-in. nut on a triple valve that the man happens to get hold of unless you have somebody there to see to it that he can't get that nut. If any railroad wants to put on the common ½-in. nut, there is nothing to prevent it from doing so.

Mr. Von Bergen: My principal point was to have a standard nut. As I stated, if the committee felt after their study of the situation that the semi-finished, or the finished nut, if you please, was the proper thing to use, then I would be glad to make use of that nut, but the point I am after is to get away from all these different nuts. If it is worth while to face that nut in order to have the threads at perfect right angles with the face of the nut, all right, that is good, but the big waste is not in the cost of the nuts now, the big waste is in having so many different nuts. The A. R. A. has a standard for practically everything they use. So long as we are using about 15,000,000 nuts a year, then I think we ought to have a standard nut of some kind on these triple valves. It is immaterial what kind of nut the committee selects so long as we have got a standard nut.

Mr. Wood: The committee would be glad to consider that, Mr. Von Bergen, if it is put to them in that way. I would like to answer Mr. Von Bergen on the 2-T test racks in service. Most of the railroads are converting those racks as fast as they find it necessary to make repairs to them of any consequence. We thought we would give the railroads the opportunity to wear out the few that they have, and probably by next year we will be ready to recommend their elimination.

The Chairman: I am going to ask Mr. Wood to talk on this angle cock situation to see if that proves interesting.

Mr. Wood: I just came from the meeting in New York of the Operating Division on the question of the elimination of angle cocks, and they were favorably inclined toward rendering whatever assistance they can to the Mechanical Division in carrying this subject along with the view of finally bringing about the elimination of angle cocks on passenger cars. The General Committee feel that the investigation made by a number of the railroads did not give the matter due consideration. A lot of their votes were based on their opinions; that is, they concluded that it was impractical to operate without angle cocks and their vote was based on that thought, and we want each railroad to conduct a thorough investigation, and if each railroad will do that they can demonstrate to themselves very easily that the angle cock can be eliminated.

In the tests that we made on our railroad the trainmen and switchmen, when we got through making the tests, asked us to let them continue with their switching operations without using the angle cocks. We were fearful that as long as the angle cock was left on, it might bring about some confusion; that is, the men would not pay proper attention to whether the angle cock

was open or closed, and consequently we had to make them go back to their former practice and watch out for the angle cock the same as they had been doing. But that shows you that the yard man, the fellow that you are fearful of, is the fellow that will do the thing twice as easy as you think he will. The only time you will have any trouble or delay on account of the non-use of the angle cock is where you have a considerable number of cars, and where it is necessary to charge the brake system. That will use a few seconds additional time, that is all. It won't be minutes or hours, and that is an occasional case. Where the operation is unusual, out of the ordinary routine, you may run into a delay.

In the beginning, if the angle cock is eliminated, I have no doubt but what you will have delays reported. You will have some properly reported, and others used as alibis for something else that occurs, but that is a question for the supervisors to follow out, and find out what was wrong, if anything, and show them what to do to correct it.

I would like to see the subject reopened, and, if necessary, the brake committee will be glad to co-operate with any of the railroads in conducting tests to show them conclusively that this is a thoroughly practical proposition and one that won't give any trouble at all, just as soon as your men are made familiar with what is necessary to get along without the angle cock.

Mr. Kleine: I want to second what Mr. Wood said in regard to operating without angle cocks. The Pennsylvania started the use of angle cocks locked in an open position the first of last October, and has been operating in regular service in all the terminals and over the entire road without the use of angle cocks and without detentions ever since.

I want to invite any of the members to any of our terminal yards and they can see for themselves the operation with the angle cocks locked and left in the open position. The Pennsylvania has gone to this in order to make a general service trial over the entire railroad.

T. L. Burton (N. Y. C.): I am fully in accord with reference to the operation of trains with and without the use of angle cocks.

I would like to say a word or two in reference to a point which Mr. Von Bergen raised and which Mr. Wood apparently overlooked, and that was regarding the renewal of rubber material in triple valves. Mr. Von Bergen spoke of the apparent shortcomings in the A. R. A. rules in that respect. Those rules prescribe what is believed to be a proper inspection of these rubber gaskets, and specify that defective ones, as determined by that inspection, shall be replaced with new ones.

Mr. Von Bergen brought this question to the attention of the committee on brakes, and we asked him to send us some samples of the ones which he thought should have been removed and he did so. Every one of them plainly showed that they were defective, and the committee therefore felt that it was more largely a question of living up to the present rules than of making additional ones.

Mr. Von Bergen: Every one of those seats which Mr. Burton looked at and which he could tell at a glance were defective were seats that some repair man somewhere said were O. K. and let them go. In so far as they cost practically nothing, I do not see why we should leave that particular feature to his imagination.

In regard to the removal of angle cocks, I, of course, the same as anyone else, can see the advantage if it is feasible to do away with angle cocks on passenger cars, but when this proposition was first proposed, we made some tests, and on one of our most important limited trains, where it is broken up with 15 min. allowed in which we used to accomplish the work with the use of angle cocks, when the angle cocks were left open for test it required 12 min. longer.

At another point where we had five minutes to do some work it required 10 min. to do it. The operating department said they could not give us more time at these points.

We made a regular service test, obtaining permission to hold the trains long enough to do it, and it was for that reason that we are not in favor of the proposition on our road.

However, I feel that our people will be glad to make some more tests, and possibly we can call on the committee for assistance in conducting the tests. It may be that it will develop that we can do this work and not seriously delay the limited trains.

R. T. Hawkins (A. C. L.): As far as the Atlantic Coast Line is concerned, we have few trains that are not cut up considerably at several terminals, particularly at Jacksonville. As far as our records go we have not had any trouble with angle cocks being turned and, therefore, we are at a loss to know why we should eliminate the angle cocks.

We have tried hard to fall in line and some tests that were made last year on the Southern were attended by our general air brake instructor. We also made some tests in our own yards. Time is an important factor and we cannot see where time is going to be gained. In fact it has taken us twice as long where we have to pick up cars and cut them out.

W. E. Dunham (C. & N. W.): Our first inclination was to be enthusiastic about the elimination of angle cocks on passenger train cars, but after actually testing it out at one of our principal terminals outside of Chicago, where we do a great deal of breaking up of through trains, we found that it was absolutely delaying us. The operating department put its foot down even on our testing.

We carried it along sufficiently to demonstrate to our satisfaction that with everyone well versed in what they should do and doing it as well and quickly as they could, for our particular situation, it was a very impractical, and therefore, we voted against such a plan. However, if the committee deems it desirable to make further tests we can arrange to carry them on again, but our operating officers are at the present time very much opposed to the idea.

H. H. Harvey (C. B. & Q.): Our experience was just the reverse of the North Western. We tried this scheme out and I might say we were all pretty well satisfied it wouldn't work, but we tried it out, and to our surprise it did work, and we are perfectly willing to go on with it.

Chairman Sillcox: Is there anybody present that has started on a campaign to reduce slid-flat wheels and attained results? We would like to hear about it.

Mr. Wood: The chart contained in our report is taken from the Santa Fe records. You might call it a campaign, if you want to, but if so, it has been continuous since we started in 1912.

The real cause of the reduction of slid-flat wheels on the Santa Fe has been the desire on the part of the higher men, mechanical and operating officers, to bring that damage down. They are the ones that are continually fighting it. Our reports go to them and they call back to us for information as to why we are having more than they think we should.

We point out to them that some flat wheels are going to occur in spite of our very best efforts, but taking the cost of damaged wheels in 1926, compared to 1911, if we had to buy that same number of wheels, at the present

day, there is a reduction of a hundred and some thousand dollars in slid-flat wheels. That has been continuous throughout this period from 1911 up to last year. It represents a large saving to the Santa Fe. To those railroads that depend entirely upon the mechanical department in all its branches, particularly the inspectors and maintenance men, to eliminate slid-flat wheels I would say that you are fighting the thing from the wrong end, because so many slid-flat wheels occur that the maintenance men are not responsible for. The operating men are responsible for a large number of them, and therefore the operating department has got to handle it from their side through the different branches of the operating department. If that is done where you are having an excessive number of slid-flat wheels, you will have a very satisfactory reduction in the number of wheels made defective from the cause.

Mr. Brazier: I move the report be accepted and the thanks of the convention be extended to the Committee for their very able work.

The motion was duly seconded, put to the convention and carried.

Report of Committee on Wheels

C. T. Ripley
Chairman

During the past year the Association of Manufacturers of Chilled Car Wheels asked the Committee on Wheels to give further consideration to the clauses in the specification regarding the sulphur content requirement and the holding of wheels for check analysis. The new sulphur requirement under this specification of 0.15 per cent goes into effect in 1927 and for this reason a careful definition of the intent of the specification is necessary in order to avoid the rejection of wheels which are satisfactory for service. The balance of the various constituents is the important factor rather than any one item. There is also a possibility of small differences in the analyses made by different chemists. The committee, therefore, wishes to make the following interpretation of the chemical analysis clause in these specifications:

Sulphur Content—The essential condition of chemical composition of chilled iron wheels is a balance between sulphur, silicon, carbon and manganese, and variation in these constitutents must not disturb this relation. If on check analysis the sulphur is found to be not more than 0.02 per cent more than specified it should not be considered sufficient cause for the rejection of the wheels, provided the wheels from this foundry have met all the physical tests and inspection and provided the manganese is, at least, three and one-half times the sulphur. Such failure to meet the specification should be called to the attention of the manufacturer and following shipments or lots must conform to the specification.

In the case of the holding of wheels for check analysis, the committee also wishes to make an interpretation as follows:

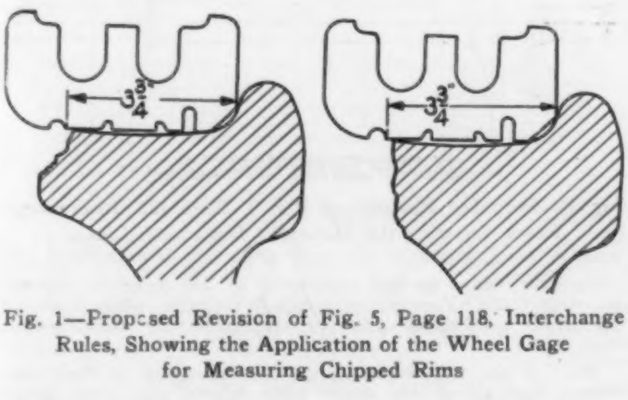


Fig. 1—Proposed Revision of Fig. 5, Page 118, Interchange Rules, Showing the Application of the Wheel Gage for Measuring Chipped Rims

Shipment of Wheels—The purchaser should not require the manufacturer to hold all lots of wheels until check analysis can be obtained unless it has been found that this particular manufacturer's output has been running outside of the specifications.

As a matter of fact, most of the railroads are following this reasonable procedure but some inspectors are interpreting the specifications in such a way as to cause an unreasonable delay in the shipment of wheels from the foundry.

The committee also has up with the manufacturers the question of reducing the flange thickness tolerance limit. The limits are now 1/16 in. over normal and 1/16 in. under normal. The committee considers this spread unnecessarily wide for good foundry practice and an investigation is now being made to see if the spread can be cut to either 1/16 in. or 3/32 in.

The committee has given further consideration to the question of increasing the thermal and drop test requirements. It has found that with the new single plate wheel, it will undoubtedly be possible to increase considerably the requirements. However, since this wheel is still in the developmental stage and is not an A. R. A. standard wheel, it does not seem best to recommend any definite change in the specification at the present time.

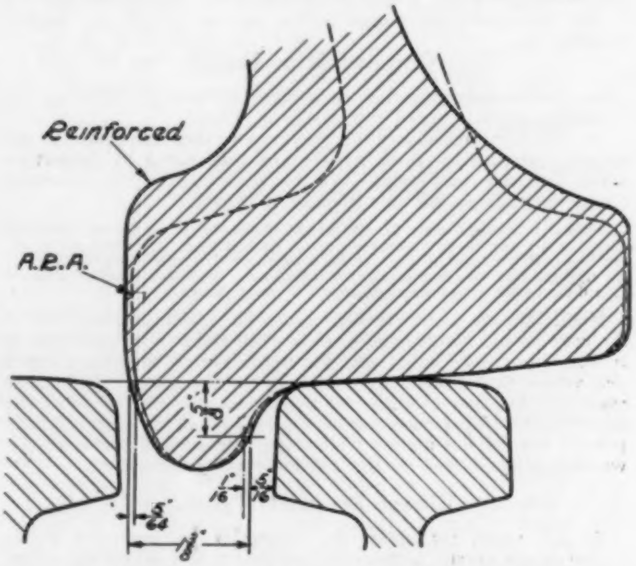


Fig. 2—The Relation of the Proposed Reinforced Flange for Cast Iron Wheels to the Standard A. R. A. Flange

Grinding of Wheels

During the past year a number of large grinding machines have been installed and we believe that the advantages of this practice are gradually being proved on various roads. A number of the portable grinding machines referred to in last year's report have been installed during the past year. These machines only grind a short distance to either side of the flat spot. Your committee hesitates to stand in the way of any possible saving of wheels but they cannot recommend an improper mechanical practice such as is involved in the use of these machines.

The practice of grinding the entire tread has been adopted as standard practice and is so shown in the manual. The application of wheels ground in this way to foreign cars is therefore permissible.

Wheel Tape

The Manufacturers of Chilled Iron Wheels have requested the Committee on Wheels to reconsider its design of wheel tape. Some claim that they have found the A. R. A. tape unsatisfactory for use in taping wheels at their foundries. The two objections which they raise are that it is difficult to get the lugs to rest against the flange, and that the kinks in the thick steel

ribbon, at points where lugs are attached, result in incorrect taping. For these reasons these foundries have continued to use the old standard tape, in which a thin ribbon is used and lugs which rest against the outside edge of the rim instead of the flange.

It is realized that the particular type of tape used is of minor importance provided the same tape is used on any two wheels mounted on an axle. Therefore, the committee is not ready to condemn the use of the old type tape for cast iron wheels at the foundries, but recommend that this question be left to arrangement between the individual railroads and wheel manufacturers. It is not felt that it is necessary at the present time to include another design of tape in the standards for use on cast iron wheels, as it has been found by most of the railroads that the A. R. A. type can be used on both steel and cast iron wheels

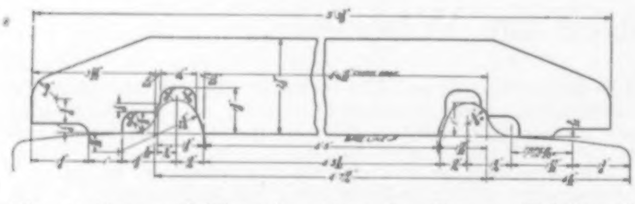


Fig. 3—Proposed Mounting Gage for Use on Reinforced Flange Cast Iron Wheels

satisfactorily. From a theoretical viewpoint at least the contact of the lugs with the flange is the correct system for taping wheels.

Chipped Rim Rule

Further consideration has been given to Rule 78 covering the condemnation of chipped rim cast iron wheels.

As has been mentioned in previous reports this rule is not entirely satisfactory since wheels are condemned by inspectors when they are serviceable. We recommend that the following change be made in this rule in order to clarify it:

Broken or chipped rim—If the width cf the tread, measured from the flange at a point ⅜ inch above the tread, is less than 3¾ inches for a circumferential distance of 2½ inches, unless the fracture extends obliquely through the rim toward the plate, in which case the wehel shall be removed regardless of the circumferential length of the fracture.

If this change in the rule is made, the figure on page 118 of the code should be changed to show both types of chipped rim as in Fig. 1. will be noted that the upper sketch shows a chipped rim where the break runs outwardly in the tread. It is such cases as this that the 2½ in. length feature of the new rule would cover. The lower sketch shows a break running obliquely inward toward the plate. Under the rule such a break as this would not be covered by the 2½ in. length requirement.

Wheel Pressure Tables

At last year's convention the committee recommended an increase in the spread between the minimum and maximum allowable pressures for mounting both steel and cast iron wheels. This was done in order to get a practical shop limit table. The cast iron wheel table was only increased from 5 to 10 tons on the maximum side but the maximums in the case of steel wheels were given a considerable increase, varying from 10 tons for the small bores to 25 tons for the large bores. Before recommending these figures the committee canvassed the various roads represented and also secured the recommendations of the wheel manufacturers.

Since the adoption of this new table, the committee has been advised by one road that it considers the spread for steel wheels too wide and may result in poor workmanship. The committee has given careful consideration to this contention but feels that no change should be made in the table, at least, until further history has been developed as to results with its use.

Tread Contours of Steel Wheels

A final report is not as yet available on the tests which committee members are running of the different tread contours on steel wheels. Figures available indicate, however, that so far as wheel wear is concerned, there is very little difference between the different contours and there is nothing to indicate that any change in the A. R. A. slope of 1 and 20 is desirable. Further report on this subject will be made when final figures are reported to your committee.

Loose Wheels

Further communication has been received in regard to the loose wheel trouble. It still develops that a large percentage of the wheels which show indications of being loose, as shown by oil seepage, are actually tight on the axles. This trouble is primarily due to the use of the wrong material on the wheel fits. The shops are careless in thinning down the paint or white lead with thin oils and also permit too much slopping over on the plate of the wheel. A proper mixture of white lead and boiled linseed oil and the avoidance of the use of excess amounts will overcome the trouble.

We do not think that the painting of match lines on the axles of the wheels is of any particular benefit and may cause incorrect conclusions if the wheels are remounted at any time and the old lines not removed.

Axle Gages

In last year's report, your committee gave a proposed method for the proper measurement of journal length. Since that time a considerable number of patented gages for making this measurement have been presented to the committee. We have advised all of these parties that the association could not adopt any patented gage and there was no particular need for one. Any gage which will measure the length in accordance with the diagram shown should be satisfactory. Unfortunately some of the gages presented do not measure the length correctly and we would suggest that the various railroads use care in the adoption of any such gages.

Developments in Cast Iron Wheel Designs

In last year's report the committee called attention to the apparent merits of the single plate type cast iron wheel and the association voted to permit the use of this wheel in interchange, the wheels to be marked A. R. A.-X. A drawing of this type of wheel was shown to illustrate where the extra strength was secured and statements were made as to the increased thermal test and drop test which these wheels would stand.

Since our last report, a large number of single plate wheels have gone into service. We have no way of getting exact figures but we estimate that close to 100,000 such wheels have been placed in service. On one road 26,000 such wheels were applied under new cars. A number of large roads have adopted this design as standard. All the reports which the committee has been able to secure indicate that the wheels are rendering better service than the double plate type. The original test of 1,000 such wheels under refrigerator cars, which was referred to in last year's report, has shown that not a single wheel of this lot has developed any inherent defects which is a remarkable performance in this particularly heavy duty service.

Laboratory tests on this single plate wheel have been made by several of the manufacturers and also by some of the rail-

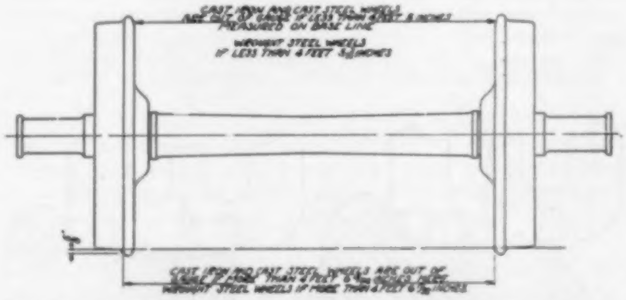


Fig. 4—Proposed Revision of Fig. 9, Page 122, Interchange Rules, Showing the Mounting Dimension Limits

roads which show marked superiority of this design in thermal and drop tests. Your committee feels that the railroads should co-operate with those who are responsible for this forward step.

Most of the manufacturers are recommending to their customers that all of the single plate wheels purchased should have the reinforced flange. The chief obstacle to a general acceptance of this flange is the fact that it is 9/64 in. thicker than the A. R. A. standard flange. Fig. 2, shows this flange with relation to the present flange. The manufacturers have presented results of laboratory tests to justify their claims for this design, and the A. R. E. A. approved of this increased thickness, so far as it affected track conditions. It is claimed by the manufacturers of the wheels that this extra metal at this point in the flange is helpful from a foundry viewpoint in the prevention of seams in the throat, which is most important to the users of the wheels. They also presented data from laboratory

tests which show that this additional metal serves a purpose so far as the flange strength is concerned, even though the breakage of the flange actually passes through the tread at the throat to the underside of the rim.

A careful review of the available facts indicates to your committee that there may be a possibility of getting better wheel service out of the reinforced flange design. The single plate design should be helpful in curing one major defect, the cracked plate, and to complete the job we should do something to help remedy the other major defect, which is the broken flange. Inasmuch as the reinforced flange will not increase the cost of wheels, it seems advisable to give the manufacturers the opportunity to do what they consider the best thing to overcome flange breakage. As a matter of fact, a considerable number of railroads have adopted the reinforced flange of various designs, as standard for their cast iron wheels and as near as we can ascertain there are about 4,000,000 of these wheels in service. Your committee has communicated with a number of these roads and they all report better service with this design of wheel.

In spite of this large number of wheels in service, there is no A. R. A. mounting gage which can be used for their mounting and they would be condemned in interchange if the A. R. A. mounting gage were applied. This is certainly an undesirable situation and the time has come when some action should be taken. In view of the probability of redesign of the standard wheel, as regards the plate, within the next year or two, your committee prefers to withhold recommendation that any change be made in the standard flange at the present time, as it would be better to make complete changes in design, both plate and flange at one time.

In last year's report the design of the single plate wheel included reinforcement rings. In the verbal presentation it was explained that these were not a part of the design but there was some misunderstanding regarding the use of these rings. It has developed that this feature is a patented one and cannot be generally used. We are calling this to your attention in order to avoid any further misunderstanding and these rings will not be shown on any other A. R. A. prints.

The use of the lip chiller is also increasing and it seems to be the general experience that this is helpful in the prevention of chipped rims. Those roads which have adopted this feature appear to be getting better wheel service. It is the committee's understanding that while this design was patented, arrangements have been made with most of the foundries in the United States for licenses at nominal figures. The new design

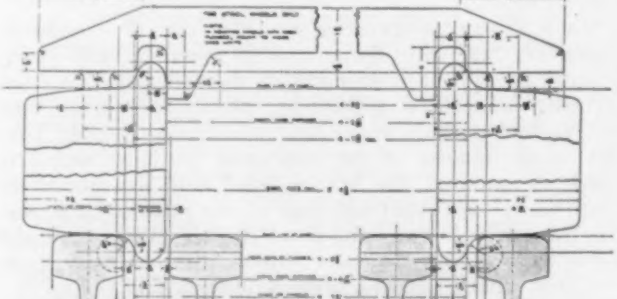


Fig. 5—Proposed Mounting Gage for Wrought Steel Wheels

of single plate wheel is particularly favorable to the use of the lip chiller due to the added metal under the rim which permits of deeper chilling at the lip.

Wheel Mounting Gage

Reference was made above to the necessity of having an A. R. A. mounting gage which could be used with the large number of reniforced flange wheels now in service. A chaotic condition would result if the rules regarding spacing as shown in Fig. 9, page 122, of the code were enforced and an unreasonable removal of wheels would result. The committee wishes to recommend at this time that a new gage be inserted in the standards as recommended practice for use in the mounting of reinforced flange cast iron wheels. This gage could also be used for the mounting of A. R. A. flange wheels without any track difficulties since the check gage distance is the same within 1/64 in. for both gages and this check gage distance from the throat of one flange to the back of the other flange is the governing factor so far as the track is concerned. Fig. 3, shows the gage which is recommended. It will be noted that the minimum back to back distance is reduced from 4 ft. 5 3/32 in. to 4 ft. 5 in., which incidentally is the present minimum limit in the I. C. C. rules. The check gage distance is changed from 4 ft. 6 29/64 in. to 4 ft. 6 15/32 in., in order to eliminate the 1/64-in. dimension. If the normal reinforced flange is 1⅛ in. at the base line and a tolerance of only 1/32 in. over normal is permitted, there will be a 1/16 in. clearance at each end of the gage when used on a maximum flange, which is the same as the present gage used on a maximum A. R. A. flange.

It will also be necessary to change the requirements of the rules, as shown in Fig. 9, page 122, of the code, by making the

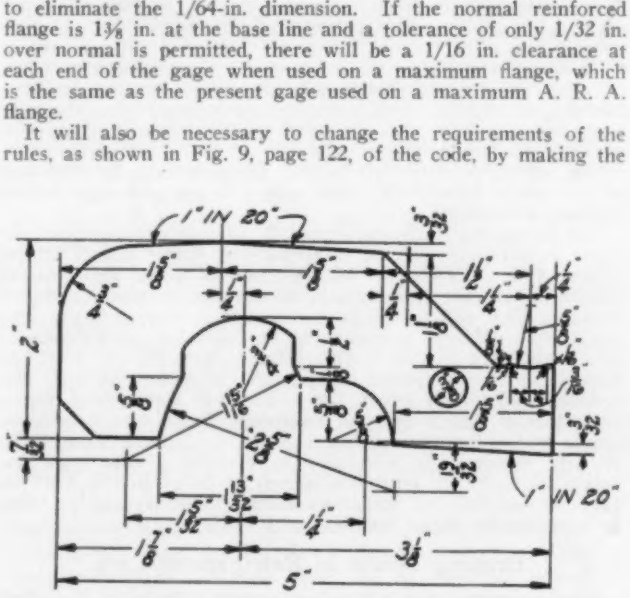


Fig. 6—Proposed Maximum Flange Gage for Reinforced Flange Cast Iron Wheels

maximum throat to back distance 4 ft. 6 15/32 in. and the minimum back to back distance 4 ft. 5 in. The latter figure agrees with the I. C. C. rule. Prior to 1909 the association had more than one gage for use in mounting; that is, there was a mounting gage, a reference gage, and a check gage which is probably the ideal system of gaging. However, your committee does not feel that they should do anything to complicate this gage situation as it is hard enough to make the operators use one gage correctly and there is a large cost involved in changing all of the gages. The recommended gage can, if desired, be made from the old gage and thus very little expense is involved. Fig. 4 shows the proposed revision of Fig. 9, page 122. It will be noted that the limiting dimensions above referred to are shown as applying only to cast iron and cast steel wheels and that another set of limiting dimensions are shown for wrought steel wheels. It is necessary to have different dimensions for the wrought steel wheels because of the fact that the flanges are of different thickness and also to make proper allowance for the fact that when steel wheels are turned, the flanges are thus restored to full contour.

The committee in its 1926 report submitted a design for a steel wheel mounting gage, in which the back to back measurement is a governing factor. There is at the present time no gage in the A. R. A. standards for use in the mounting of steel wheels. After further experience with the use of this mounting gage, the Committee on Wheels now makes the recommendation that it be put in the manual as recommended practice. Fig. 5 illustrates this gage.

The second paragraph of Rule 24 prohibits the mounting of two wheels on the same axle where the thickness of the two flanges combined exceeds the thickness of one normal and one maximum flange. In view of the action of the committee in establishing a new mounting gage for use on reinforced flange wheels, it appears that this paragraph is not necessary in the rules. It is therefore recommended that it be eliminated.

Wheel Defect Gage

The attention of your committee has been called to the fact that a number of wheel defect gages have been turned out by the gage manufacturers which have the wrong radius at the corner for measuring the vertical flange. The A. R. A. drawing, as shown on page 110 of the code does not show a radius dimension, though it is evident that the radius should be ⅞ in., as is shown in the proceedings. For some reason this dimension was left off the drawing and should be restored at the next

revision of the manual. The use of any other radius will give an incorrect measurement of the vertical flange.

In this connection, the committee wishes to call attention to the fact that enough care is not being used in the manufacture of new gages of all kinds. A number of gages have been called to the attention of the committee which were not made in accordance with the A. R. A. drawings. Some of the manufacturers apparently have not realized the importance of accuracy in the manufacture of such gages and the railroads have not realized the importance of checking all new gages before placing them in use. The practice followed by some of the railroads is to have all new gages checked over by the engineer of tests, or other designated official, and after being passed by him, stamped as correct. Your committee recommends that the railroads consider some such procedure as this. It may also prove desirable to have a master gage of each type held in the office of the secretary of the Mechanical Division, in order that any of the roads may check their master gages and thus insure absolute uniformity.

The committee does not think it necessary to change the wheel defect gage for use on reinforced flange wheels at the present time. Ultimately as these wheels come into general use, the gage can, if necessary, be changed so that the flange thickness limit will be 1⅛ in. instead of the present 1 in. The use of two different gages would be confusing, as the inspectors might have trouble in differentiating between the A. R. A. flange and the reinforced flange. As a matter of fact, the vertical flange limit of ⅞ in. is the real condemning factor in cast iron wheels and the reinforced flange wheels will be caught by this limit before they reach the one-inch thin flange limit. It will, however, be necessary to provide a new gage for maximum flange for reinforced wheels as shown in Fig. 6. This gage is used only by inspectors at the foundries and provides for a maximum flange thickness of 1 13/32 in.

Braking Power of Refrigerator Cars

Your committee has in previous reports referred to the effect on wheel service of the high braking power ordinarily applied to refrigerator cars and other cars of high light weight. Under the present system of brake design these cars do an unreasonably large proportion of the braking for the train. The result is that the wheels are subjected to high stresses in the plate and the treads develop brake burns rapidly. If the braking power on these types of cars could be reduced so that it would be more nearly equal to that of other cars, there would be less plate breakage in wheels and also a considerable saving due to the reduction in the number of wheels removed for brake burn.

This question has been referred to the Committee on Brakes and Brake Equipment and it is hoped that prompt action will be taken by this committee toward finding a solution.

The Wheel Manual

A number of suggestions have been made for changes in the tentative wheel manual, which was presented in 1925. However, the final results of the study of steel wheel defects is not as yet available and in view of this fact and also the possibility of some major changes in standard cast iron wheel designs and gages for the same, it does not appear desirable for the committee to issue the final manual at the present time.

It may be mentioned that a very large amount of work has been done by the sub-committee of your committee during the past year in an exhaustive investigation and study of steel wheel defects. There are many difficult questions involved in this study. A committee of the manufacturers and this subcommittee have gone over defective wheels and a complete record has been made of the same. The laboratory study of these wheels is not as yet completed but it is hoped that out of this study we may be able to present to you a definite classification and definition of the various steel wheel defects which will help to clear up the confusion which now exists in this regard. We wish to acknowledge the active co-operation and assistance of the manufacturers in this important work. We regret that the final results are not in shape for presentation in this report but we consider the subject of such importance that we wish to have the complete data available before their presentation to the association.

Conclusion

The committee recommends submission to letter ballot of the following items which have been discussed in this report:

(1) Adoption as recommended practice, mounting gage for reinforced flange cast iron wheels.

(2) Adoption as recommended practice, maximum flange gage for reinforced flange cast iron wheels.

(3) Adoption as recommended practice, mounting gage for wrought steel wheels.

The report was signed by C. T. Ripley, (chairman), chief mechanical engineer, Atchison, Topeka & Santa Fe; O. C. Cromwell, assistant to chief of motive power, Baltimore & Ohio; H. W. Ostrom, chief chemist, Chicago, Milwaukee & St. Paul; G. B. Koch, general foreman foundry, Pennsylvania; H. W. Coddington, engineer of tests, Norfolk & Western; A. Knapp, inspection engineer, New York Central, and John Matthes, chief car inspector, Wabash.

Discussion

Mr. Smart: A large number of railways have been using the reinforced flange, and we have not had the proper gages for the mounting of these wheels. The time has come when we should make the change and go to the reinforced wheel, and the time to make it is on this single-plate wheel. The manufacturers must change their patterns and other tools in their foundry, if we adopt the single-plate wheel, and we should be prepared to advise them as soon as this thing is passed, that the reinforced flange will be made a standard of this association.

Mr. Dunham: The Chicago & North Western has been using this reinforced flange for approximately 12 years on the double-plate wheel on both locomotives and cars, and we have had most excellent results from it. We had a lot of trouble at one time with broken flanges and a seamy condition in the throat, which was all stopped by the use of the reinforced flange.

As to this eccentric grinding of wheels, the past year we have been making some experiments and find that within limitations we can use this eccentric grinding machine to save a great many wheels that are taken out of service with a great deal less than the 2½ in., containing the flat spot, and the wheel, if ground, will meet the requirements of the rotund gage and will not be over the 1/32-in. out of round. Cast-iron wheels, in most cases, have that eccentricity. We have found that with our necessity for taking wheels out of service that have 1-in. or 1½-in. flat spots, we can use those wheels again. We would like to suggest that in checking the use of this particular machine the committee look into the proposition of limits.

Such a plan as eccentric grinding can be carried to extremes, but with limitations it certainly will bring about a great deal of economy to the railroads. We are figuring on making a positive rule in the winter time not to run a wheel under a freight car with over 1-in. flat spots, because of the difficulties we have with our track in some of the branch lines and less important main lines. We don't feel that we are justified in throwing those wheels away and if we can recondition and still have them within the same limitations that we require for new wheels, we are perfectly justified in doing it.

Mr. Chambers: I am glad to see consideration given to the reinforced flange cast-iron wheel. The C. R. R. of N. J., about 12 years ago, had 500 gondolas built with reinforced cast-iron flange wheels. We met with some trouble later on, with the rails wearing the shoulder on the inside of the flange. We probably took most of the wheels out and machined them down to get rid of that shoulder. We found some complaint from the interchange roads about their condition.

A. Knapp (N. Y. C.): The subject of wheel defects is delaying the issuance of the manual which was presented to the association in 1925. We are working with the steel wheel manufacturers on this subject. One of the things that we would like to achieve is a distinction between the various types of defects. At the present time it is necessary for the railroads to send special representatives into various shops to distinguish between the types of defects with which we are troubled in wrought-steel wheels, as well as other types of wheels. We hope, eventually, to prepare a set of photographs

and a description of the various types of wheel defects which will enable the shop men to report these troubles correctly and avoid unnecessary expense. We hope also, eventually, that it will be unnecessary to worry about some of the defects with which we are troubled at the present time.

A. G. Pack (I. C. C.): Mr. Ripley spoke of these changes which they propose making as coming more within the I. C. C. requirement. I suppose he refers by that to the locomotive inspection rules. I want to assure the organization that so long as I remain at the head of the Bureau of Locomotive Inspection, I am always willing to co-operate with you in bringing about changes that may better the service, and if our rules are in conflict with what thorough investigation may develop, we will go along with you. We do not want to hinder progress.

Mr. Ripley: Mr. Dunham raised a point in regard to making a limit for the use of the portable grinding machine. I have not as yet been able to see how such a limit could be made. We are certainly open to suggestions. The committee would like very much to hear from Mr. Dunham as to how such a limit can be made. Portable grinding machines, that is, nothing but a motor-driven emery wheel, are being used to smooth off the edges of flat spots so that they won't take the gage and the wheels are turned out within the limit. I will agree with him that there are now some railroads that have been grinding wheels perfectly well with such a machine, but how are you going to get those limits? There are machines available to do the work right at a low cost. Two machines in the year 1926 on one railroad netted $55,000 profit. Is it a good investment to get a machine that does not do the work right when you can get a machine that does it right and make money for you? We are certainly not anxious to condemn anything which is going to save anybody money if there is a possible way to get it done, and put proper safeguards around it to protect other railroads in interchange.

As to the point Mr. Chambers raised, after thorough investigation of the wheels, he will find that that is the old sloping-back, reinforced flange which has been abandoned by the manufacturers because of the trouble mentioned. If you will notice the new design, it does not have the sharp slope on the back flange which is probably the source of the trouble.

Mr. Robbins: Who of those who have been using the single-plate wheels have run into any difficulty in maintaining the A. R. A. mounting pressures? Also has any change been necessary in the mixture of the steel to maintain the proper chill?

Mr. Ripley: I am familiar with that trouble. Some hubs have broken at the outside end during mounting. That trouble has apparently been confined to the products of a very few foundries, and my understanding is that they are meeting it through slight changes in pitting, the temperature at which the wheel is taken out of the sand, etc. It may ultimately require a slight redistribution of metal, and I am not sure but what a little more metal around the outside edge of the flange may be a benefit. You realize in this single-plate wheel the projection of metal in the hub would naturally invite the trouble to which you refer. We have just mounted 26,000 of these wheels, the product of four foundries, and have not had a single case of that kind develop, but I know it is something that has developed, and I know that the manufacturers are working on it. I believe they will meet it to your full satisfaction.

Mr. Robbins: How about the change in the mixture to maintain the chill?

Mr. Ripley: That has not been found necessary to any great extent. We have not had any trouble with the chills. I have the records on these 26,000 wheels which indicate the chill running practically the same as the other wheels. I think perhaps a study of the individual conditions in that foundry might show you the reason for that chill. As I understand the manufacturers, they do not feel that the single-plate wheel design should in itself alter the chill to any great extent, though they do change in practice somewhat the amount of time they leave it in the sand before they take it to the pits. The real trouble is the fact that the mass of metal at the hub is more subject to the drawn hub refect. We have not been able to get any evidence that a drawn hub makes trouble, but yet there are many railroads who feel it should be avoided. Therefore, the manufacturers are trying to make the wheel in such a way as to eliminate this drawn hub, and I may say they are all making progress. Remember it is a new article for them and they all have to feel their way more or less in the early stages.

John Purcell (A. T. & S. F.): In 1912, when we started after slid-flat wheels, we also started after the truing up of the wheels. We have reduced the slid-flat wheels 60 per cent since 1912 and have practically doubled the business on our road. I hope the time is coming when every railroad in the United States and

100-Ton Oil-Electric Locomotive Built Jointly by the Ingersoll-Rand, American Locomotive and General Electric Companies, in Switching Service at Minneapolis, Minn., on the Great Northern

Canada will grind every wheel under a freight car before it is put under the car. I am quite satisfied that if you will have a record made of the damage to the commodities in cars with eccentric wheels that you will agree with me that you can reduce your loss and damage to the commodity in your car more than you reduce the amount of your wheel cost.

Mr. Brazier: The grinding of cast-iron wheels will increase their life and give you an easy-riding car. You don't have much trouble with your steel wheels, if you turn them when they are on the axle. Some master mechanics turn steel wheels and remount them. That is not safe practice.

The report was accepted and referred to letter ballot.

Report on Lubrication of Cars and Locomotives

G. W. Ditmore
Chairman

The purpose of this committee is to make an investigation of the general lubrication of railway equipment. The major consideration leading to the appointment of the committee was the proposed revision of Interchange Rule 66, covering the periodical repacking of journal boxes, which was approved at the annual meeting of the division last June. The committee was instructed to give attention to specifications for the following: (a) Packing journal boxes; (b) lubricating oils, and (c) oil reclamation.

The methods of packing journal boxes was first given attention, based upon the "Recommended Practice," adopted by the division in 1920. The Committee has prepared a revision of the "Standard Method of Packing Journal Boxes," adopted as Recommended Practice, in 1920, and now recommends Exhibit A for advancement and adoption as Standard Practice.

Saturation of Waste

A mechanical method of saturating waste for journal packing is commonly practiced, which simply allows the waste to soak in warm oil a sufficient time to absorb the necessary amount of oil. A long time is required by this process to saturate new waste in order to completely impregnate the fibre, because of the confined particles of air within the fibres. It is necessary to remove the air to permit complete saturation. A vacuum process will accomplish this operation at a great saving of time. The reason for requiring that the oil be extracted from the packing is, that it may be reclaimed and eliminate the dirt from the oil, resulting, also, in economy in the cost of journal lubrication.

Reclamation of Packing

The reclamation of waste from journal box packing and the preparation of the packing should be done at a central plant according to the requirements of a given railroad system. All journal packing should be handled in closed metal containers to and from the reclamation plant. The back rolls and the front wedges, or plugs, should also be prepared centrally, and shipped with the packing. The reasons for handling at central points are to secure a uniformly better product, and to obtain a lower cost of preparation consistent with the better product. An objection may be claimed that the cost of handling will be increased, but it is believed that the improved results obtainable will justify the increased handling charges.

Reclamation Plant for Journal Packing and Oil

The committee has visited one of the reclamation plants on one of the large railway systems.

The old journal packing is shipped there from all points in the district in steel drums. These are first weighed. After the packing is picked over, and lumps pulled apart, it is put into a vat of hot oil for a few minutes, stirred with a fork and placed on a drain board. This process removes most of the fine dirt and some of the short ends and babbitt pieces and washes the waste. It is then put into a centrifugal machine and the oil extracted. The waste is transferred to a laundry machine consisting of a horizontal cylinder of woven wire screen and operated in a combined rotary and oscillating motion, thus "rumbling" the waste and sifting out the dirt and short ends. The waste is also subjected to a warm air blast to remove the moisture and restore resilience. It is then placed on a tray having a coarse screen at the bottom, and is loosened by hand over the screen, when it is transferred to the saturating machine.

In the saturation process a known weight of waste is thoroughly impregnated with a known quantity of cleaned oil in about two minutes by the use of a vacuum and pressure method.

The prepared packing is then put into steel drums, weighed and is ready for shipment.

Oil Reclamation

The oil constitutes 80 per cent of the product used for lubricating journals. Therefore, it is essential that the oil be as free from contamination as the waste which conveys it to the journal.

Dirty car oil will contain from 2 to 15 per cent of moisture and freewater and from 5 to 12 per cent of ash, i.e., grit and solid matter.

By good filtering processes it is possible to greatly improve the condition of the oil, reducing grit and solids to less than 5 per cent, but without eliminating the moisture.

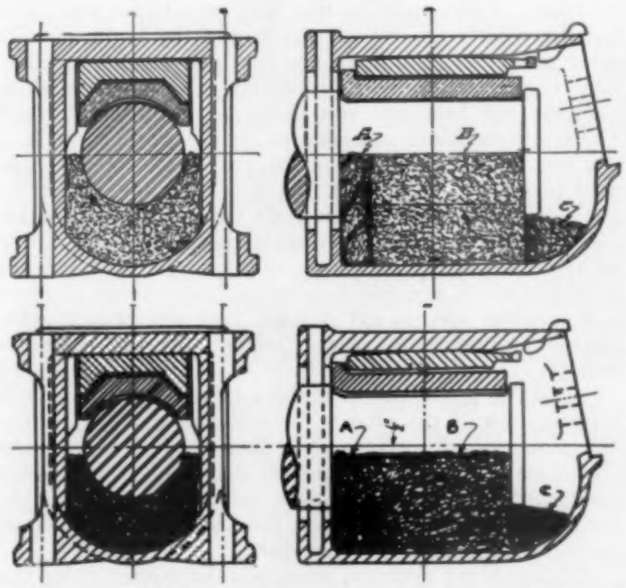


Fig. 1—Drawings Showing the Present Recommended and the Proposed Methods of Packing Journal Boxes

Three methods are used at present for reclaiming the oil extracted from journal packing.

Filtering—Various mechanical types of oil filters are in service on some roads employing strainers or straining materials, or both. This process eliminates most of the dirt and solids.

Separating—The centrifugal method, utilizing machines of the cream separator type, are also employed, and frequently are used after the oil has been filterd.

Heating the oil to the boiling point, to drive off the water, where practical, must be done carefully to avoid explosions and scattering of the fluid.

Chemical—In connection with filtration there may be added a chemical process which breaks down the emulsion formed after heating and stirring of dirty oil and eliminates the moisture after the free water has been removed. This method is, undoubtedly, an advance step in successfully restoring oil to its original condition, rendering it as serviceable for lubrication of new oil. This chemical and renovating treatment employs, successively, a series of tanks for collecting the old oil from the cleaning vats, treating it with chemicals, evaporating the moisture, separation of solid matter and for storage. The filtering or the separating processes will render the oil about 95 per cent pure, while the chemical will produce an oil over 99 per cent pure.

The committee's conclusion is that any of these three meth-

ods may be utilized with resulting improvement and economy over the simpler methods frequently employed.

Application of Packing

In the application of packing to the boxes, the Committee feels that the improvements will result from the changes outlined, as follows:

a—The back roll is specified 3 in. diam. to insure ample size to make contact on the journal fillet and excluded the dust. The lengths of roll will vary to suit the diameter of journals.

b—The proposed rule describes a good method of forming packing in one piece, keeping the top of packing a half inch below the center line of journal. This is already the practice on many roads, to avoid waste rolling under the bearing.

c—The committee recommends the use of the wedge, or roll, at the outer end of the journal box. While a few roads do not use it in packing their own boxes, the majority of roads do use it, and some of the roads running through extremely sandy territory insist that such wedge is necessary to seal the box against excessive dirt.

Inspection

The importance of proper methods of packing journal boxes requires that the employees performing this work be fully instructed. It is suggested that a full sized model be used for the better instruction of journal packers. The model of the box should contain the journal, the journal bearing and the wedge. Both sides of the box should be provided with doors, or slides, covering glazed openings for the observation of the interior. Demonstrations with this model would illustrate clearly the right method of applying packing.

Rules for inspection of journal boxes are submitted in Exhibit D.

Locomotive Lubrication

The committee can only report progress on the studies of locomotive lubrication. It is preparing to assemble informa-

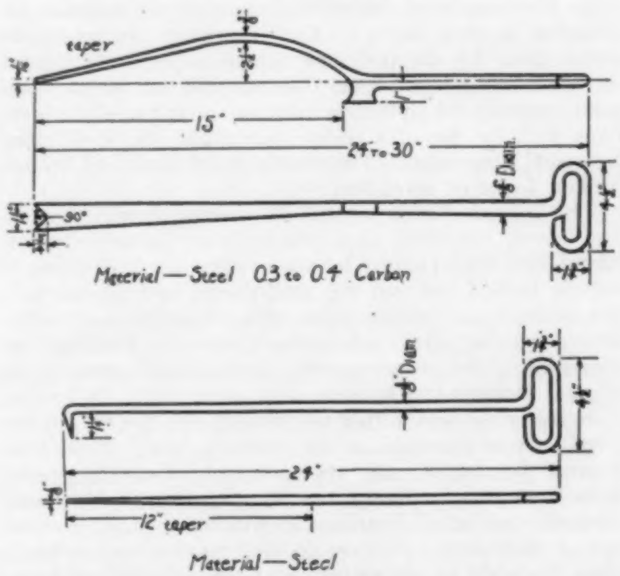


Fig. 2—Recommended Design for Journal Box Packing Tools

tion for development for next year's report, provided the commitee is continued.

The report is signed by G. W. Ditmore (chairman), Delaware & Hudson; H. W. Johnson, Minneapolis and St. Louis; P. Maddox, Chesapeake & Ohio; T. O. Sechrist, Louisville & Nashville; G. E. Dailey, Chicago, Burlington & Quincy; M. J. O'Connor, New York Central and C B. Smith, Boston & Maine.

Exhibit A—Method of Packing Journal Boxes

(The proposed Standard Practice is a revision of that adopted in 1920, instructions being clarified and amplified. Instructions for preparation of renovated packing have been added to and should insure better results. Bored or broached bearings are called for and instructions added relative to worn or defective wedges. Rules for application of packing have been extended and improved.—*Editor.*)

Exhibit B—Specifications for Dust Guards

Purpose—To exclude dust from the journal box and to retain the oil.

Requirements—To serve its purpose the guard must fit the axle tightly at all times.

Material—Must be flexible in the portion in contact with the axle in order to take up wear as it occurs and such portion must be resilient and durable. No metallic portion of guard, if used, shall be allowed to come in contact with the axle during the life of the guard. Material must be heat-resisting and non-breakable in service. The guard must be easily applied.

A wedge or plug shall be applied to close the top of the guard-well in the box, or provision made in the construction of the guard to close this opening in order to exclude dirt.

Service—The service life of the guard shall be equal at least to the service life of a pair of new wheels. The common wood dust guard shall not be considered as complying with these specifications.

Exhibit C—Specifications for Journal Box Packing Tools

Two packing tools (shown in Fig. 2) are required for packing journal boxes.

The packing iron is used for inserting packing and pushing it into proper place in the box. This tool should be 24 in. to 30 in. long, and made of ⅝-in. round steel of 0.3 to 0.4 carbon to insure holding its proper shape in service. The blade or spoon portion should be 14 in. long to permit proper packing of the longest journals. The blade should be provided with suitable curve and offset to permit working the tool properly inside of the journal box. A "fish-tail," 1¼ in. by ⅛ in. should be formed at the end of the blade, to facilitate pushing the packing into place. A lug for lifting and closing box lids conveniently should be provided on the shank at least 15 in. from the end of blade. The handle should be formed by bending the iron into an oblong loop 4½ in. by 1¾ in. outside dimensions, and centrally located at the end.

The hook is used for withdrawing packing from box and pulling out wedge and bearing. It should be about 24 in. long, of ⅝ in. round medium steel and provided with a handle similar to packing blade. The hook end should be first tapered for about 12 in. from end to lighten the weight and to permit easy access between wedge and journal. The hook, about 1¼ in. long, should be formed by bending the end at a right angle.

Exhibit D—Inspection of Journal Boxes

An inspection shall be made by raising the box lid and examining parts and conditions as follows:

1—Feel in the back of the box with a packing tool to see if packing has worked away from the fillet of the journal.

2—If the packing has settled away, it must be set up to the journal with the packing tool.

3—If the packing is found to be glazed on surface in contact with the journal, the surface should be broken up with the packing blade and the waste worked over to bring a fresh surface against the journal, being careful that loose ends are tucked in.

4—The top of the packing should be kept not over a half-inch below the center line of journal.

5—When removing the outer wedge, or plug, it must be kept separately, to avoid getting dirt from it into the packing.

6—When pin-grease or any other cooling compound is found mixed with the packing, all such packing must be removed and the box repacked with fresh packing.

Such compounds, which will lubricate a hot box after it is too hot for oil lubrication, will, if left in the box, cake over and prevent oil feeding up through the packing.

7—If packing contains water, the box should be repacked.

8—The end of the journal must be inspected carefully to note its condition.

When the center is found to be dry, it indicates there is poor lubrication, defective journal bearing or dry packing, and the bearing should be removed for careful inspection, and renewed, if defective.

9—When bearings have to be renewed on account of heating, a careful examination shall be made of the condition of the journal before applying the brass.

10—The brass must be examined to determine if the lining is squeezed or broken out. This may be done by running the packing hook along the lower edge of the brass.

11—The end of the brass must be examined to determine if it is broken or cracked.

12—See if brass and wedge are in proper positions.

13—After inspection is completed, no strands of packing should be left hanging out of the box, and box lid must be closed tightly, to exclude dust.

Discussion

M. J. O'Connor (N. Y. C.): Our years of experience in handling rolls has demonstrated that a roll 2½ in. in diam. and 10 in. in length is more serviceable than rolls made of various lengths and diameters, when it is considered that it is not the intent of the roll to lubricate the journal, but to better exclude the dirt and keep the oil in the journal boxes. A roll made of these dimensions does not come in contact with the journal but is slightly above the dust guard opening in the back of the journal box.

The use of a wedge, or so-called dirt seal has proved superfluous. It has been our experience in packing journal boxes, that with the so-called continuous strand—which has the effect of binding all of the packing in the mass flush with the inside face of the collar of the journal—the front plug is not necessary. Furthermore, this so-called front plug interferes with the proper adjustment of packing on cars in train yards, for the reason that yard forces and time are each usually limited. It is needless to say that these plugs are not always removed when it is found necessary to adjust packing. It

is almost impossible to determine whether or not the packing in journal box has worked to the front in boxes where this plug is used. This plug also hampers inspection, particularly in connection with the so-called dry centers, for the reason that it is impossible to maintain with any degree of accuracy the size of the plug in the front of journal boxes, with the result that the oil from this plug keeps the end of the journal oily at all times.

E. Von Bergen (I. C.): It is imperative that many of the committee's recommendations be adopted as standard requirements in connection with Rule 66. It is to be regretted that they did not specify the maximum allowable dirt or foreign matter in renovated oil and renovated packing. Analysis of much of the renovated packing in use will show that this limitation is badly needed.

Specification No. 3 is somewhat indefinite, if a so-called compensating or adjustable dust guard alone is specified, I do not believe it advisable, as a one-piece composition flexible guard with not more than 1/32-in. clearance on the axle will be found just as efficient as a laminated wood adjustable guard.

Under proposed Rules 1 and 6 of the proposed method of packing journal boxes employees who prepare packing are likely to drain it too dry. To make clear to them the proper condition of completed packing, the following sentence should be added—"Oil should not drip from drained packing when lifted from the draining rack, but oil should flow from it when squeezed in the hand."

Proposed Rule 12 specifies the method of forming the back roll. These rolls can be spun on a motor driven spindle, and the product is equally as good as though hand-made and twine bound and at much lower cost. This should be optional.

Proposed Rule 12 (b) specifies when applying packing between back roll and wedge or dirt seal, to allow strands to hang down outside always adding more packing before placing the hanging strands inside the box. There is serious doubt that this is good practice. My personal opinion is that the only purpose these overhanging strands serve, is to drag dirt clinging to the outside of the box, into the box. A much better job will be done by placing this packing one section at a time with the hand, then pushing each section home with the packing iron. About three sections will fill the space between the back roll and wedge, and when properly placed, they will remain in position, and it is unnecessary to bind the packing in one mass. It is difficult to do a first class job when an attempt is made to apply this packing in one mass as specified.

Approximately a year will elapse after the Rule 66 becomes effective before any substantial improvement will be noticeable. Therefore, even if the General Committee does not again postpone the effective date, it will be 1929 or 1930 before any improvement is effected. In the meantime, I would recommend that the committee be instructed to study the following conditions and method suggested for correction, to be incorporated in Rule 66, and report their recommendations to the convention in 1928:

1—A large force of oilers or box packers is employed in train yards by each railroad for the purpose of giving so-called attention to journal boxes. Ninety per cent of the work of these men consists of hurrying along the side of a train, and jabbing the front plugs with the packing paddle. This work is worthless and such journal boxes would be as well off if these men stayed at home. In fact, in most cases the boxes would be better off, as the front plug is nearly always coated with dust, and these men punch it under the journal, sooner or later causing a hot box. With the high speed movement of freight trains through terminals today, the train yard is no place to work journal boxes.

Remedy—Take the oilers out of the train yard and put them on the repair tracks. One man can properly repack five times as many boxes on a repair track as he can in a train yard during a given period of time on account of the time lost in walking long distances to and from the soaking vat or dope house to the cars in train yards. In addition to the annual repacking of journal boxes on repair tracks required by Rule 66, provide for pulling and repacking journal boxes each time cars are on repair tracks for any other cause when the packing stencil is more than three months old, this work to be charged to car owner. Twelve months is entirely too long to expect packing to function successfully.

2—The work of adjusting packing in journal boxes on in-date cars on repair tracks, if done at all, is now largely performed in a slipshod manner, and little, if any, benefit is derived from it. This lack of proper attention is a prolific source of many hot boxes.

Remedy—Add to Rule 66 specific instructions covering the manner in which this work must be performed as follows: Insert a wire or slender packing hook as a feeler to determine if packing is firmly in contact with the journal all the way back and if the back roll is in position. If not, or if the packing is above the center line of the journal on the sides, remove the front plug and work the packing into the proper position, then firmly replace the front plug. Do this each time cars are on repair tracks, for other causes and at handling lines' expense.

3—Thousands of hot boxes develop on account of defective bearing linings. Car inspectors are unable to detect these by the ordinary visual inspection followed on practically all railroads. On one railroad in one train yard recently 94 defective linings were found in four days with the use of a feeler, that could not be detected by visual inspection. These defects consisted of linings broken, loose or spreading.

The source of this trouble is relining bearings without boring the shell, as a proper bond between babbitt lining and shell cannot be made when the old lining is merely melted out and the shell-tinned and melted babbitt poured on. Aside from this, many railroad shops where bearing shells are relined have no facilities for determining the proper quality of the babbitt used or the proper melting heats.

Remedy—Adopt a rule prohibiting the use of any relined journal bearings, as the cost of a new 5-in. by 9-in. journal bearing is only approximately 35 cents greater than the cost of relining, the benefits derived fully warrant the casting all bearings in which the lining is worn out or defective. If it is decided to continue relining, then it should be mandatory that the old shell be bored with at least a 1/32-in. cut after the old lining is melted out and before relining.

4—Many cars are sent off repair track with defective bearings or cut journals, the latter because when the car was inspected at interchange it could not be plainly seen that the journal had been hot. This results in more hot boxes.

Remedy—Adopt a rule providing for inspecting journals and bearings with a feeler while cars are on the repair track, and replace any defective bearings or cut journals found, the expense to be charged to the owner, except where packing stencil is less than three months old, in which case the road which applied the stencil shall be responsible for the charges.

I know of no feature which has greater need of immediate attention by this association than the enormous

loss now being suffered annually on account of hot boxes on freight cars, and the above suggestions are based upon five years of intimate contact with the problem on repair tracks and train yards.

L. J. McLain (D. & H.): The dimensions of the packing iron outlined by the committee show a length of 4½ in. and a width of 1¾ in., the iron to be made of ⅝-in. material. That either makes the iron too wide for a man to take hold of properly or not sufficient for a man to get his hand on the inside. I think that the handle should be either widened at this particular point or closed altogether.

Having inspected the packing in a great number of journal boxes, I find that some roads are using 100 per cent wool, other roads 100 per cent cotton, others a varying percentage of wool and cotton, some fiber and still others are using springs. It would be well for the committee to set a standard as to the waste to be used.

Mr. Smart: I want to supplement the remarks about this handle. I do not know whether any of you gentlemen actually ever worked as a car inspector in a cold climate. I have had to wear a pair of mittens on my hands and you cannot handle a packing iron like that. You want to have a handle large enough so a man can put his hands right on the handle.

G. S. Goodwin (C. R. I. & P.): I would like to ask the committee what they had in mind on a dust guard that must be flexible and a portion in contact with the axle in order to take up wear? We are using some dust guards that we think are fairly good guards and they are not flexible where they fit on the axle. Have we got to give them up?

G. W. Ditmore (D. & H.): The committee had in mind making a dust guard of steel which would be heat-resisting and also have leather or some other material around the axle so that it would be flexible at all times and take up the wear as the guard wore. I do not know of any specifications for such a dust guard at the present time.

Mr. Dunham: I question the feasibility of adopting the procedure of packing journal boxes and preparing the packing as indicated here as a standard. I think it would be well for the committee to consider that as recommended practice for a while and not start out with a new procedure which is going to require considerable change on most railroads in the way of preparing packing.

Mr. Kleine: We have Rule 66 which was passed last year and which I objected to at that time as being a little bit too soon to be put into effect. However, I went home and started in on the lubrication of journal boxes in accordance with that rule. We have never been able to reclaim oil by the filtering process because we could not get all the dirt out nor could we get the water out. We tried out a 50-gal. barrel of oil in a De Laval separator, but before we got 25 gal. of that oil through the separator we ruined the separator. We, however, went to a system of chemical cleaning of the oil after filtration and we were able to restore the oil to practically a new basis, just as the committee says in the report. As an association I do not think we ought to adopt anything as a standard that is not right. Unless we can clean this oil properly, or make a specification for cleaning the oil, or indicate how it should be cleaned, or how much dirt and water should be left in the oil, I do not think we ought to adopt that as a standard. I am not talking against Rule 66 because I am going along with it, but I think it is probably a little early.

B. H. Gray (G. M. & N.): Has the committee concluded what should be the definition of a hot box?

C. B. Smith (B. & M.): Practically all of the replies to the questionnaire asking for a definition of a hot box evaded the actual definition. Substantially no one attempted to define what a hot box is. Obviously, it is a box the temperature of which exceeds to some extent the normal temperature by which it can run cool. Undoubtedly, the practical answer sought was one which caused any detention necessitating a report as such, either in service on the road or at a siding or otherwise.

The report was accepted and the committee continued.

Banquet on Tuesday Evening

A radical departure from the usual program of the Mechanical Division was a banquet on the evening of the first day of the meeting. There was an attendance of about 700. The affair was somewhat similar to the annual dinner of the American Railway Engineering Association at Chicago in March, except that there were a large number of ladies among the guests. The purpose of the banquet was to promote acquaintanceship at the very beginning of the meeting, so that the members could make the best possible use of contacts with representatives from other roads during the remainder of the convention.

G. E. Smart, vice-chairman of the Mechanical Division and chief of car equipment of the Canadian National Railways, was the toastmaster, and short addresses were made by Sir Henry W. Thornton, president and chairman of the board of directors of the Canadian National, and Grant Hall, vice-president of the Canadian Pacific. A considerable number of entertainment features were interspersed throughout the program.

Toastmaster Smart in presenting Sir Henry Thornton, said: "I am going to introduce to you a man that has done the greatest welding job that has ever been done on a railroad. He has fused four distinct railway organizations into one good, harmonious working organization. It has taken him less than five years, and I do not know of any man that today is any better acquainted from the Atlantic to the Pacific. I have great pleasure in calling on Sir Henry Thornton.

Steam Locomotive Holds Its Own

Sir Henry Thornton: Those who represent the mechanical Division of the American Railway Association have been engaged for many years in improving that fine, old servant of the North American railway system known as the steam locomotive. Every few years somebody collects a sheaf of flowers and brings them to what is thought to be the funeral of the steam locomotive, but somehow or other it continues doing business at the same old stand in the same old way, and apparently with improved efficiency. It is a matter of congratulation to the mechanical genius of the railway industry that the locomotive has been developed as it is today, and that it is so efficiently playing its part as an instrument of propulsion.

In the early '90s the United States was just springing into its industrial destiny. Great combinations were forming in the steel trade and other industries. Business was forging ahead by leaps and bounds, and that meant that a tremendous traffic burden was placed upon the transportation systems, and unless those transportation systems had succeeded in rising to the emergency the

progress of the United States industrially would have been seriously retarded.

What part did the mechanical experts of the railway industry play in making possible that continued development? I say, without fear of contradiction, that it was the introduction at that critical period of heavier and constantly heavier vehicles of greater capacity which permitted the United States to develop as rapidly as it did develop.

The railway industry is confronted by two conditions which work to reduce net earnings—constantly decreasing freight rates, and constantly increasing wages. True, the civil engineer in improved track and permanent way has played his part, but I venture the assertion that the great economy in railway operation which has permitted railway companies in the United States to meet the burden of lowering rates and increased wages has been the genius, vision and courage of mechanical engineers.

Tribute to Mechanical Department

In looking over the last 30 years or so of the railway industry in the United States, the Mechanical Division may congratulate itself upon having largely contributed to the achievement of two objectives: first, the railway companies have handled a constantly increasing traffic successfully and to the satisfaction of the shipping public; and secondly, economy of transportation as a result of mechanical progress has permitted the railway companies to maintain solvency. No finer contribution could be made to any industry than those two objectives which you gentlemen of mechanical science have accomplished.

I think sometimes what you have done is insufficiently known, and it is a pleasure to take advantage of this opportunity to pay a well-merited and well-deserved tribute to the mechanical engineers of the railways.

However important mechanical progress may be; however important improved transportation methods may become; however important any activity of any of the railway departments may be, the whole thing, and all of the efforts of any department is subordinate to one single fundamental fact, which is the genesis of the railway business, and that is getting the traffic.

A well-handled train, a skilful engineman, a polite conductor, a good dining car service, all of these things contribute to getting traffic, and I claim that every officer and every employee of a railway can contribute something in the course of the year either directly or indirectly to attract traffic to the railway.

Your function as mechanical engineers is to provide a constantly improving power, to maintain your power and equipment in a serviceable condition with minimum cost, but back of all that is getting the business. By doing your job successfully and efficiently as mechanical engineers you are not so much helping the mechanical department of your railways as you are helping the traffic department.

Traffic Is What Counts

I often think we become blinded in the railway business by the suspected importance of our own immediate work. We feel that the department in which we work is fundamentally and primarily essential for the existence of the railway, and that most things in the railway are subordinate to that department. But, after all, it is teamwork, it is co-operation, that gets the traffic, and unless there is traffic to haul there will be no traffic department, no maintenance department, or no other kind of department.

If I might venture to leave any message with you as one who may have had some experience in the railway business of more than one country, I would say this: That however necessary your progress may be, the essential thing is to see to it that you play your share and your part successfully in getting traffic to your railway.

Grant Hall Introduced

Toastmaster Smart: The gentleman that I am going to introduce to you now is one whom many of you have met through his associations with the Mechanical Division. He started his railway career as an apprentice in a machine shop, and worked his way successfully through the mechanical department until now he holds the position of vice-president of the Canadian Pacific. That railway extended its lines across the continent 60 years ago. It is celebrating this year its sixtieth anniversary which is also coincident with the sixtieth anniversary of the Confederation of Canada and of the organization of the Master Car Builders' Association.

The Canadian Pacific Railway played a great part in the confederation of Canada. President Beatty is now in western Canada and greatly regrets his inability to be here. I now have great pleasure in calling on Grant Hall, vice-president of the Canadian Pacific.

Achievement of Mechanical Associations

Grant Hall: Let me welcome you to Montreal as an old member of the Master Mechanics' Association. The Master Car Builders' Association was formed about 1865 and reorganized in 1882. The Master Mechanics' Association followed about one or two years later. In 1919 the Master Mechanics' Association and the Master Car Builders' Association joined together and formed what is known now as the Mechanical Division of the A. R. A., and if I remember correctly my very good old friend, who has now gone beyond, William J. Tollerton, was president at that time.

You have a great record behind you in the Master

Mechanics' and the Master Car Builders' Associations. The work you have done stands and speaks for itself. One or two outstanding accomplishments include the recommendation and the adoption of the automatic brake and the automatic coupler. But the greatest thing to the credit of the Mechanical Association is the general rules of interchange which have made it possible to handle the present-day traffic conditions.

M. J. Gormley Discusses Results of Car Efficiency

Underwood & Underwood

M. J. Gormley

In his address, M. J. Gormley, chairman, Car Service Division, showed how effectively the program of the railroads to provide adequate transportation service had been carried out, and discussed some future possibilities. His address is given below in abstract.

The Car Service Division, in reality, is employed to police the carrying out of the Car Service Rules, which are designed to return cars to the owning lines, either loaded or empty, in such volume as to meet the traffic requirements of the individual owning lines and insure the proper maintenance of the equipment.

Car Distribution

We have three major problems of car distribution: The return of refrigerator equipment from the large consuming territories of the districts east of the Mississippi and north of the Ohio rivers to the producing territories of the west and south; the return to the western agricultural territory of the equipment that has been used in the transportation of agricultural products from the west to the large consuming territories of the east and south, and the return of coal car equipment to large coal producing lines from lines beyond the car owners' rails.

The population of the territory west of the Mississippi river is 17 people to the square mile, and east of the Mississippi and north of the Ohio is 156 to the square mile. Seventy-two per cent of the total grains and 72.5 per cent of the total animals and products are produced in the western district. On the other hand, 72.6 per cent of the manufacturing establishments, as measured by their capitalization, are located east of the Mississippi and north of the Ohio rivers. This densely populated eastern territory is a very large consumer of the agricultural products of the west and south. The heavier traffic, therefore, is constantly eastbound and northbound into this large manufacturing territory of the east and the lack of westbound and southbound traffic in equal amount makes necessary the continued return to these territories of empty equipment. Unless this equipment is moved regularly from day to day, either loaded or empty, congestion would very quickly result in the eastern territory, and with a shortage of equipment in the west and in the south.

Adequacy of Transportation

The adoption by the railroads in 1923 of the "Program to Provide Adequate Transportation Service" is now well known to all. It has been carried out in its entirety and no doubt the results obtained are far beyond the fonest dreams of the railroads at the time of its adoption. The railroads recognize that adequacy of transportation at all times, regardless of conditions, is their duty.

During 1926 there were loaded 53,308,753 cars, the largest year's business ever handled by the railroads of this country. The average daily surplus of equipment during 1926 was 205,054 cars, and the lowest surplus, at the time of the heaviest loading, was 88,130 cars.

Efficiency in Car Handling

Miles per car per day have increased from 27.8 in 1923 to 30.4 in 1926. Tons per loaded car originated, averaged 34.5 in 1923 and 35.1 in 1926. The demurrage assessed, averaged over the number of loaded cars, excluding merchandise and l.c.l., amounted to 75 cents per car in 1923, and 56 cents per car in 1926.

The tonnage figures show, as to the items of coal, sand, stone and gravel alone, that the tons per car obtained in 1926 over 1923 was 1.7 tons. Had there been no increase in the tons loaded per car in 1926, compared with 1923, it would have required the handling of 396,000 additional cars to have moved the 1926 tonnage of these commodities. Furthermore, had there been no increase in tons per car in 1926 compared with 1920, it would have required the handling of 801,000 additional cars to have moved the 1926 tonnage.

The wheat loading in 1926 averaged 1.3 tons per car more than in 1920. Had there been no increase in tons per car, 1926 compared with 1920, it would have required the handling of 19,477 more cars to have moved the 1926 tonnage.

We believe the mechanical officers of the railroads can point with pride to their foresight and ability which brought about the more modern and efficient car which makes results such as these possible.

Possible Results of Car Efficiency on Car Ownership

The addition of 608,777 modern, high capacity cars, either new or rebuilt; the retirement from service of 552,358 low capacity, inefficient cars; the placing in service of 11,049 locomotives since January 1, 1923; the co-operation of the shippers through the medium of the Regional Advisory Boards and the important part they have played in reducing the time required for loading and unloading of equipment, as indicated by the decreased demurrage assessments; and, to some extent, an increase in the loading per car, were the main factors that made it possible for the carriers to handle the greatest traffic in their history, and, at its peak, to have available a large surplus of equipment. A recent report of the Car Service Division, which has been approved by the Board of Directors of the American Railway Association, reads, in part, as follows:

After very careful consideration of this question of the economical use of cars, the Car Service Division believes that it is possible to handle the traffic of the country for some time to come with a total decrease in the ownership of open top and box cars of at least 100,000, provided:

(1) That there be a continuation of the replacement of the smaller capacity and less efficient cars with cars of modern type.

(2) That there be a continuation of the present plan of maintaining equipment at the highest practicable point, as determined by the necessities on the individual railroads.

(3) That there be a further increase in the miles per car per day of at least one mile.

(4) That further intensive consideration of the load per car be given by railway management and all the Advisory Boards with a view of increasing tons per car to the greatest possible extent and not less than average of one ton per car.

(5) By careful supervision on the part of industries as to loading and unloading of equipment with a view of making a

reduction of at least 20 per cent in the amount of demurrage assessed during the year 1926.

The Car Service Division recognizes that these conclusions as to car ownership would not apply to every individual railroad, there being without question some lines requiring a larger proportion of new equipment to meet their increasing traffic necessities than would be applicable to the lines as a whole.

This suggestion of the Car Service Division, if carried out, will be a complete fulfillment of the aims of the railroads, with the assistance and co-operation of the shippers, to handle an increased traffic with a decreased expense for overhead in car ownership.

We call the particular attention of the mechanical officers to the part which they should play in this proposed program of reducing the total ownership of equipment by replacement of the less efficient with more modern type equipment, and by maintenance of the equipment to the highest possible standard.

You will note that here, again, you are called upon to shoulder a major part of the problem. We are not unmindful of the fact that the replacing of obsolete equipment is not entirely within the control of the mechanical officers, but they certainly are in position to point out to their executive officers where they can make a good return upon the investment by retiring some of the older type and less efficient equipment. In other words, you must necessarily put yourselves in the same position with your own executive officers as the salesman who is selling you a machine tool, on the basis of proving to you that its purchase will bring about such a reduction in your operating and maintenance expenses as to justify the expenditure.

Empty Car Mileage

The very vital and important question of empty car mileage is receiving constant consideration and study by the individual railroads with a view of its reduction to the lowest possible minimum. One thing necessary on the part of any railroad in dealing with empty car mileage is to maintain such checks and records from day to day as will insure that there be no unnecessary movement of empty equipment in the direction of the preponderant loaded movement. We know that in the opposite direction there must be an empty movement, which is unavoidable. The principal causes of empty car mileage and its variation from year to year are largely due to things over which the railroads have no control.

If you will examine the records of your individual railroads you will see that the best records in the percentage of empty mileage have been made during periods of congestion, and coincident with that has been car shortage. Empty cars standing still do not make mileage, but they do cause car shortages. Generally speaking, when you have an increase in the miles per car per day, one period compared with another, it indicates a more prompt movement of all the empties, better service to the public, and also an increase in the percentage of empty mileage.

Capital Expenditures and Operating Expenses

The addition of large numbers of modern cars and locomotives, heretofore referred to, in addition to improvements in terminals, reduction in grades, etc., has meant the expenditure of large sums of money to provide the adequate transportation service now being rendered. During the past six years the railroads have made an expenditure of $2,450,751,648 for equipment and $2,102,726,104 for other improvements, a total of $4,553,477,752. The other side of the story is that the operating expenses for 1926, when the heaviest traffic on record was handled, $1,112,600,000 less than 1920. True, this reduction was not all due to the improvements made in the physical plant but certainly the largest part of it was due to that fact. These results, to my mind, not only prove the wisdom of what the railroads have done to provide more adequate transportation but also point the way to what they must continue to do in the future to provide for the constantly growing traffic demands of the country.

Without the money to pay, a railroad, of course, is handicapped. It cannot buy equipment; it cannot maintain its road and equipment; it cannot secure the latest improvements; it cannot, in a word, adequately finance its operation. It goes without saying, therefore, that unless a railroad can earn a reasonable and safe margin above expenses, it is very definitely limited in its ability to furnish transportation service. We believe this is now fully understood by not only the governmental regulatory authorities, but also by the public.

There seems to be no question but that employees can be secured in ample numbers, and with training and ability to carry on railroad operations. There appears to be no limiting factor in this respect.

As to physical equipment, there will be no question, with financial ability to purchase, and with man power to operate.

The ability of a railroad to furnish transportation service may be modified by the shippers' capacity to load and to unload. To be an active element in the transportation machine for manufacturing transportation service, a car must move. If I asked you now to close your eyes and think of a freight car, I have no doubt that a vision would come to you of a car standing still and not in motion, but only a moving freight car actually manufactures transportation service. A car standing awaiting a load, or a loaded car standing awaiting to be unloaded are both an obstacle to the free movement. The greatly increased car efficiency in the past few years is due in a considerable measure to the very active co-operation of the shippers with the railroads through the Regional Advisory Boards. With the continuation of that co-operation and a better knowledge on the part of shippers and receivers of freight of their responsibility in bringing about a more economical operation, through better utilization of the plant available, and with the financial ability of the railroads assured, there need never be any question in the mind of anyone as to the ability of the railroads to meet the transportation demands of the future, regardless of what they may be.

Discussion

Prof. W. J. Cunningham (Harvard University): Why did Mr. Gormley not take the average ton-miles per car day to clinch the argument of movement and load and empties all in one factor? That, I believe, has shown a commendable increase.

Mr. Gormley: The answer to that is that we appeal to the shippers to increase the load per car. The movement has some effect on the ton-miles per car days. The figures that I present to you are the tons actually loaded in the cars regardless of the distance moved or tons originated. I believe that when we appeal to a shipper we should appeal to him on the things that are his business and not appeal to him on the basis of l. c. l. tonnage.

On 72 per cent of the tonnage in 1926 the tons per car, except l. c. l., either equalled or exceeded any previous year. About 49 per cent of it actually excelled all previous records in the tons per car. That is our

reason. It is a better indication of what the shipper is actually doing. As a matter of fact, we are going to hang our hat on this thing and appeal to the shippers to do their part in attempting to bring about a reduction of 100,000 cars in ownership and cut the overhead that much.

The Chairman: I hope you did not miss the point Mr. Gormley made, that we could do away with 100,000 cars in this country; that is, at least, something some of the car men can touch on.

Mr. Tatum: We are now considering a standard hopper car. A lot of us differ on what the dimensions should be. I do not care personally what they are, but I do want to see Mr. Gormley get just what he wants. If you give him what he wants, he will give the public what they want, and the public and Mr. Gormley will give the railroads just what they need—a car that will carry the greatest revenue load with the least dead weight.

The Car Construction Committee, or subcommittee, designed a hopper car which could be loaded with three pounds of revenue load to each pound of dead weight. I do not know of any other car that so nearly meets that comparison, and I am sure if the Car Construction Committee goes along on the work as they have, and the railroads of the country co-operate with them, as they have shown a disposition to do, that Mr. Gormley and the public and the railroads will get exactly what he said he should have to save 100,000 cars in the railroad car equipment stock.

Mr. Smart: Mr. Gormley's paper has brought out some of the things that our mechanical officers are endeavoring to do, and that is, to maintain the modern car and do away with the obsolete car. That is the ideal to which the mechanical officers are working and which they would like to attain. If we can do with 100,000 cars less, just imagine what this means. Based on some of these figures we have been talking about, the average cost of maintenance per car per year is, say, at the maximum, practically $150 a car. There is $15,000,000 less in the maintenance we are going to get away from, plus interest on the investment and the depreciation.

Trends in Engineering Education

By A. A. Potter
Dean of the Schools of Engineering, Purdue University, Lafayette, Ind.

A. A. Potter

There are many people who are constantly finding fault with our type of civilization and are singing the glories of the good old days. These critics of our times find nothing to commend about a civilization which by releasing an enormous amount of mechanical power to supplement human labor has produced comfortable modes of living for everybody. They find little to praise in a civilization in which there is so little difference between the rich and the poor as far as the food they eat, the clothes they wear, the convenience of their homes, the educational advantages they enjoy, or the general conditions of life which tend to raise all normal minds to a common level of happiness. The contrasts of poverty in the good old days may have been more inspiring to the poet, but the lack of inequality among civilized people and their comfortable living is much more conducive to human welfare.

Engineering strives to provide better and easier ways of satisfying human needs. During the last 25 years science and engineering have richly contributed to human welfare by elevating social conditions and improving standards of living. If our people are more prosperous, more comfortable, and more happy because of the abridgement of distance through modern transportation facilities; because of the use of mechanical power and machine-made products; because of the ease of communicating with others by means of the telegraph, telephone and radio; because of the development of the electric light, artificial gas, the X-ray, the moving pictures and the talking machine; because of the adequate water supply, safer sanitary arrangements, better buildings, streets and roads—if for these reasons life is now better worth the living than ever before—it is because scientists, inventors, railroad builders and engineers have for a generation been working quietly, persistently, and systematically to confer these benefits on mankind as their contribution to the economic progress of human society.

Are there any factors which are contributing more to human welfare than the railroads? Who should receive the greater credit for the stability of the United States and the Canadian governments—the politicians, the law makers, or the railroad builders? Does the average person appreciate his indebtedness to engineering of which railroading is an important part? Those who are responsible for our prosperity are keeping silent while the critics of our type of civilization, who care little about true values, are minimizing the true worth and work of those who are responsible for the development of our railroads, utilities, factories and public works.

Engineering as It Affects National Prosperity

Competent American and foreign investigators attribute our industrial prosperity in the main to four causes:

1—Higher level of intelligence throughout American industry as compared with industries of other countries.

2—Large use of power and of machinery to increase the effectiveness of human labor.

Over seven mechanical horse power are available per capita of the United States population, the equivalent of at least one hundred slaves. This enormous strength of ours in the form of mechanical power has stimulated industrial development to such a degree that the American worker turns out more goods, commands higher wages and lives better than any worker in the world.

Engineering demonstrates that the most efficient way to utilize man's capacity for work is to allow him by his skill and knowledge to direct and control machinery by which work is performed.

3—Low cost of production of manufactured goods in large quantities, leading to an abundant supply of goods at low prices.

Modern production methods are the application of engineering to manufacturing problems. The science of management is a branch of engineering and the elimination of strikes in industry during recent years has been attributed by many to the engineer-manager.

4—High wages, causing a large public demand for manufactured products.

These four conditions are to a large measure the results of popular education and the work of the engineer. The American engineer is concerned not only with materials, methods and machines, but also with management, men, money and business policies.

Industry and Engineering Colleges are Interdependent

The rapid growth in the number and in the enrollment of the engineering colleges in the United States and of Canada during recent years is in part an indication that there has been public approval of the type of education offered by these institutions. Conditions on this continent have also been particularly favorable to engineering education because of our unusual natural resources; also because of the rapid growth of our industries and public utilities, which are dependent upon men who are technically trained.

You, the railroad men of this country, whether you received your education through shop apprenticeship or by special schooling, are engineers, in the proper sense of the word. Your

contact at all times with technological problems enables you to appreciate the value of the engineering college as a time saving device for those who are expecting to devote their lives to railroading, manufacturing or other careers which require special technical knowledge.

There is a greater realization at the present than ever before of the value of technical education. The importance attached to engineering training not only for technical positions but also for administrative and executive posts is demonstrated by the fact that practically all of the major executives of the electrical manufacturing industries and of the electric utilities are technically trained engineers. The experiences of manufacturers and of electric utilities with college trained engineers have resulted in a constantly increasing demand for the product of engineering colleges.

With the increasing complexity of modern railroads, their constantly growing dependence upon technological improvement and new leadership, they are bound to have an increasingly close and direct interest in the product of the engineering colleges.

Are the railroads of the United States, Canada and Mexico attracting their share of engineering college graduates? If not it may be well for the American Railway Association to study the experiences of manufacturers and of electric utilities in recruiting, training and advancing college trained engineers, so that a plan may be perfected whereby the railroads of this country may be in a position to attract the most gifted and the best trained of the youth of this generation.

Engineering Education in the United States and Canada

About 160 colleges and universities are giving in the United States and Canada under-graduate engineering instruction to about 60,000 students. Contrary to the general impression the curricula of these engineering colleges *are not specialized*. Our students receive during their four year under-graduate engineering course at least two years of work which would be acceptable toward a degree in practically any college of arts and sciences. The professional training of the engineer must be gained largely in the field, as engineering service does not conform closely to definite types and it is impossible to foretell the intellectual requirements which will be demanded of the engineering graduate in practice. Collegiate curricula in engineering are based primarily on the principles of science and mathematics. They are intended to precede and supplement but not to supplant practical experience in industry. Engineering colleges do not claim to be able to graduate men who are competent, without a long period of practical experience, to run a railroad or to hold down any other important technical or executive position. The testimony of those who have been employing engineering college graduates gives ample evidence to the soundness of engineering education in its general plan.

The median earnings of engineering graduates are as follows: 5 years after graduation $3,000, 10 years $4,000, 15 years $5,000, 20 years $6,000. These figures show very clearly that the engineering college graduate does not expect large compensation until he has established himself and has learned the practical details of the business he has chosen to enter.

The facilities for engineering instruction of collegiate grade are more than adequate. In fact it is doubtful as to whether the United States and Canada need 160 engineering colleges to meet the present requirements for the training of engineers of the professional grade.

Non-Collegiate Technical Instruction

Our present facilities for the non-collegiate type of technical instruction are extremely meager and are absolutely inadequate for the proper training of men for the junior technical and supervisory positions of industry. Neither are our facilities adequate for the preparation of unskilled workers.

Many are forced to leave school at an early age. The preparation of these young people for useful service to industry and for good citizenship is of great importance to the public. Modern industry has been compared to a building of several stories with no inside or outside elevator or stairs. The unskilled workers find employment on the lowest story, the next two stories are occupied by semi-skilled and skilled workers, while the executives occupy the top story of the industrial structure. A comprehensive system of technical education should prepare the worker so that he can enter from the outside any of the stories of the industrial structure: it should also provide part-time courses, short-time courses, continuation schools and correspondence instruction for the worker now in industry so that he can climb from one place to another as rapidly as his natural ability and ambition will *permit*.

Some of the Continental European countries have several well defined levels of technical education. At the top are the technical universities, which are similar to the best engineering colleges of the United States and Canada and which admit only those who have completed the full program of secondary education. At the middle of the scale are numerous technicums which admit those who have continued their studies to the age of 14, and which train for the junior technical and supervisory positions in industry. At the bottom of the scale are apprentice schools for skilled workers.

We need on this continent more technical schools of a distinct non-collegiate type, briefer, more intensive and more specialized than the programs of engineering colleges. There is also a need for high grade technical instruction by correspondence for the benefit of those who are now employed in the shops and plants of our railroads, industries and utilities.

Railway Motor Transport

By F. J. Swentzel
Mechanical Superintendent, New England Transportation Co.


F. J. Swentzel

Our company, which was organized in Massachusetts on June 15, 1925, and which started operations August 10, 1925, anticipates for the year ending December 31, 1927, operating about six million motor coach miles, carrying about four million people at a cost of about 29 cents per coach mile, which would include all costs.

This mileage will be run off on 43 routes, including six summer routes and will involve over 190 motor coaches, 13 automobiles and 4 trucks—total number of units, 207. Of the 190 motor coaches, 74 are the four-cylinder type and 116 are the six-cylinder type; 50 are semi de luxe cars and 140 de luxe cars:

The four-cylinder coaches are used for handling the shorter local traffic and the six-cylinder parlor cars are used for the longer haul routes. A considerable percentage of our service is run in place of or auxiliary to the New Haven steam railroad service and this service in itself effects a considerable saving to the New Haven railroad in lieu of steam service and in itself justifies the operation. In addition to this saving, we are in position, we hope, to earn a net this year independent of the above.

In addition to the regular operation of the schedule which we cover, we in our own territory reach out for and are getting considerable so-called "party business" covering movement of special parties to and from cities within our steam railroad limits. This business is attractive as it has a tendency to utilize our surplus equipment, which is necessary for us to have to cover peak load days on Saturdays, Sundays and holidays and which can well be utilized for special party business on the first five days of the week. Our present tariff covering this service is 50 cents per mile for revenue mileage and 30 cents for necessary deadhead mileage with four hours free turnaround time after which we receive $4.00 an hour for waiting; the minimum charge for special party service is $30.00.

Our chartered coach miles in 1926 were about 92,000 miles and we anticipate doubling this mileage in 1927.

While the steam railroads and the trolleys have a function of their own, there is in and around New England a very large percentage of local travel, for one reason or another, who desire motor coach service and patronize it freely, thereby creating a very fertile field for this class of service on the highway and with particular reference to service between cities and towns approximately 50 miles apart.

There is also a considerable demand for the so-called special party business in and around New England covering seashore

resorts and the mountains during the summer. This is particularly true in metropolitan Boston, which area includes a 50-mile radius and which has a population of approximately two million people.

We believe the service is one of public necessity and that it will increase, as in many cases it provides the only service which some of the smaller towns have. Railroad stations and trolley service are frequently some miles distant from the town activities. This highway service has a tendency, in our opinion, to build up rural communities and also has a tendency to create both additional and better highways.

The number of motor vehicles on the highways has increased very rapidly during the last 25 years until this business is one of the biggest in the country today involving approximately twenty-five billions of dollars if the highway improvements are included. It seems to me that this speaks for itself so far as the effect of motor coach operation is concerned.

The Problems of Maintenance

As with the steam railroad, the earning power of a transportation company depends largely upon the efficiency of its power. There is nothing, in our opinion, that will reduce the net income quicker than poor or deferred maintenance. In taking up the maintenance problems of a fleet of motor coaches or trucks, I wish to call your attention to a very important factor, which will have a great bearing on a successful and economical operation.

Make a very careful and thorough study of the physical characteristics of the territory through which the routes are to be operated, so that you will be able to select the coach or truck equipment best suited for your operation. This can very easily be accomplished with the information you can secure from the carriers now operating coaches and through unbiased engineering advice, which is possible to secure; consequently, careful consideration should be given to the selection of your equipment, for your success will greatly depend on this. No amount of good management or skillful maintenance can result in unqualified success if your equipment is unsuitable or poor.

Before your actual operations begin, you should organize and equip a mechanical facility for the purpose of maintaining your fleet from the beginning. Do not allow yourselves to go into deferred maintenance, as you all know it is very expensive and requires a great amount of unnecessary work to put the equipment back in good mechanical condition.

Regardless of the physical conditions of the operation, I do not think it necessary to purchase more than two different types of coaches. With trucks, one make with a range of capacity from 1½ tons to 5 tons with trailers of 10 tons' capacity for terminal transfer jobs.

The purpose of calling your attention to the advisability of standardizing on the least possible makes of units, is for two reasons: first, the difficulty of being able to stock parts economically. The more makes and motors you have, the greater the difficulty in this respect. Second, the modern motor coach is less than four years old and mechanical improvements, which are being developed by the different manufacturers, are at a very rapid rate, so much so that it is almost impossible to keep up with them. For instance, a comparison of the first ten coaches delivered to us a year ago last December and the last ten, with a period of only ten months having elapsed between these delivery dates, would cause you to doubt that they had been manufactured by the same company.

Where an operating company is compelled to route its coaches through two or more states, it is confronted with a very serious problem in endeavoring to comply with the large and varied number of laws enacted, covering the public utilities and motor vehicle commissions; therefore, it is more than advisable to secure the services of an expert and qualified automotive man to inspect the chassis and body construction as they are being built, so that they will meet your specifications and the requirements of the different state laws when they are delivered to you. Up to very recently we did not have one piece of equipment delivered to us, which we could place in service, without a great number of changes and improvements being made by us.

A very important fact in economical maintenance is the protection of your equipment from abuse and mishandling by the coach operators. To best overcome this, a prospective operator should be turned over to the mechanical department by the operating superintendents, after he is qualified for employment, with a view of ascertaining if the applicant is able to judge speed and distance well enough to operate a motor coach or truck safely (the handling of both are very similar). After he proves to us that he is capable in this respect, he is placed in school under a capable mechanical instructor, not with the idea of making a mechanic out of him, but to acquaint him with the general construction of a unit, what damage is done by improper handling and how to make minor road repairs, such as locating a defective spark plug, bad electrical contact and the replacement of burnt-out electric bulbs. If the operators are able to take care of these minor troubles, it saves a great many unnecessary trips with the service cars.

It is quite difficult to secure all round automotive mechanics, as men of this type are few and far between. Another feature in connection with transportation which has a tendency to interfere with securing mechanical help, is the fact that it is a seven-day job. In the organization of our shops in Providence, I endeavored to eliminate the all round mechanic by employing men who have specialized in one particular branch of the industry. This has worked out very satisfactorily in every way and I strongly recommend an organization of this kind.

Organization of the Providence Garage

As to the shop organization at Providence, I have laid it out covering two departments, or I might say two different classes of work. The back shop men, who work six nine-hour days a week and cover the machine, body, paint, blacksmith and welding jobs and the other men, whose duties are general servicing and running repairs, who work nine hours a day seven days a week covering 24 hours a day. This layout also has a tendency to facilitate the work in the auditing department pertaining to labor classification and the difference between running repairs and servicing and major and general overhaulig.

The Providence Garage Is Equipped with Four Electrically Operated Screw Hoists

The complete personnel of the main shops at Providence consist of one chief clerk, one secretary clerk and two stenographer-clerks in the superintendent's office. In the shop proper are:

1 general foreman	1 blacksmith
3 assistant foremen	3 firemen
16 first class mechanics	2 machinists
7 second class mechanics	4 helpers
4 painters	2 greasers
3 body workers	2 electricians
1 welder	2 inspectors
1 chauffeur	3 washers

This gives a total personnel of 58, with a storekeeper and three clerks in the stores looking after that department.

The machine tool equipment is complete in every detail. We can machine any part of a motor vehicle; we regrind our cylinder blocks, crank shafts, cam shafts, pistons and piston rings. Our electrical department takes care of all our generator, starter, magneto and battery repairs as well as battery charging. We make all body repairs, both metal and wood, handling blacksmithing in all its branches, except spring repairing; our spring breakage is so small that it would not be economical to operate our own spring shop. The paint shop has a capacity of three jobs in eight days. These shops take care of approximately 143 coaches, including major overhaul and servicing.

We are painting our coaches by hand, using a maroon shade of enamel. It requires more time to paint by hand, but we are convinced that it is the most satisfactory way of applying enamel.

Question of Standardization

We have drawn up our own body specifications, covering both de luxe and semi de luxe types of body, embodying the

features best suited for our particular operations and covering in every detail the requirements of the public utility and motor vehicle commissions in the states in which we operate. This also gives us one more standardization, something that is very desirable for a number of reasons, the most important of which is a more economical maintenance.

We have also a set of specifications covering the chassis and compel the manufacturer to comply with them, except where it might have a tendency to interfere with the general design of his unit.

Another problem, which confronted us in our operation, was brakes. We were continuously involved in any number of arguments with the state authorities over the lack of efficient brakes. There was also the danger to lives and property, which we were anxious to eliminate. After considerable experiments, we replaced defective brakes with the installation of Westinghouse air equipment and eventually will use a metal to metal brake. Other than a few minor troubles, and these we have remedied, we are satisfied that it is the proper brake equipment for both coaches and heavy duty trucks.

We have had developed by the Corbin Company a speedometer head without the odometer mechanism, which gave the company more space in the head to perfect an accurate speed indicating instrument. This instrument has two hands on the dial, one of which shows the actual speed being maintained and returns to zero when the coach is not in motion; the other remains at the point of maximum speed attained. These are checked at the terminals at the end of each trip. If it shows a speed of more than 30 miles per hour had been reached, it is reported with the operator's name to his superintendent, who in turn takes what action he deems necessary for disciplinary purposes. Our speed

The Machine Shop of the Providence Garage

rule makes it a punishable offense if he exceeds 30 miles per hour. The head of this instrument is locked and requires the use of a key to reset the maximum speed hand back to zero. These instruments are also sealed, and between the lock and seals, it is impossible for anyone to reset them without the use of a key and plunger.

System of Inspection

We have at all large terminals mechanical department employees, whose duty it is to inspect all arriving coaches, covering motor, motor oil level, tires, steering gear, brakes, lights and body damages. We also inspect every coach nightly after it has been turned over to us by the operating department. This inspection covers all parts, which should they fail to function properly, would cause a road failure or accident, general condition of the motor, bodies, lights, oil level and includes checking up for oil change and greasing mileage. The value of both the terminal and nightly inspections is best shown by our records for the Saturdays, Sundays and Mondays of Memorial, Independence and Labor days of last year. We went through these nine days of peak load holidays without a mechanical road failure. We have had a few accidents caused from defective parts, not detectable by inspection, but we have not had one which could be caught by inspection.

The manufacturers of motor coaches need educating in what is best suited for a safe and economical operation, and I am more than confident that the carriers with the assistance of their automotive engineers are best qualified to do this. To give you an idea of what I mean, I might take up the filling of coaches with gasoline. Our coaches all have tanks of 50 gal. capacity and the filler pipes are so small in diameter that it takes from five to twelve minutes to fill the tanks. This causes overflow waste of gasoline on the ground and it also interferes greatly with the maintenance of our schedules.

Maintaining a fleet of motor vehicles is quite a problem when they put up at your own garages, but it develops into a much greater problem when your fleet is scattered from Provincetown on Cape Cod to the eastern boundary of New York State, relying on another subsidiary of the New Haven at four points, 25 public garages and shops at other tie-up points, with our own eight shops to service and keep in repair our fleet. This requires a great deal of mechanical supervision that would not otherwise be required.

Mileage of Buses for Lubrication and Repairs

There is a great difference of opinion in regard to the proper greasing of the chassis and renewal of crank-case oil. We have given these conditions very careful study and after thorough tests we adopted the following: We grease universal joints and steering gear parts at 500 miles; the complete chassis at 1,000 miles; a complete crank-case oil change at 1,500 miles.

There are at least two practical oil filters on the market for unit installation that are not only practical but will, I am sure, triple our present oil mileage when we are in a position to install them. I have made a careful study of oil reclaiming operations and I am convinced that nothing is to be gained by using them in their present stage of development.

Another question which comes up from time to time is what mileage period should a coach or truck be given its major overhaul and when should maintenance cease and replacement take place. In the first place, it is impossible positively to fix the replacement period, for replacement of parts takes place in a great majority of cases before the unit has covered any great mileage. The proper general overhaul, including replacement, can only be governed by the physical characteristics of your operation and the service required of the units and if they are being furnished with the proper grade of oil and lubrication.

I am sure that 85,000 miles, under normal conditions, is about the proper period that may be figured on for the first major overhaul. This major overhaul, including the reboring of blocks, with, of course, oversize pistons and rings to fit; replacement of bearings in some particular makes of units and in some cases new timing gears, the regrinding of crank-shafts and the refacing of valve seats and general overhauling of the electrical equipment, with, in most cases, replacement of parts.

If a coach which has been shifted to an isolated point has had a major overhaul, or in other words had work done on it, which takes it away from the manufacturer's standardization and that coach breaks a piston or burns out a bearing and we at Providence are called upon to furnish this part, we must be in a position to send them a part that may be fitted with the least amount of labor; consequently, it requires us to keep a complete record in my office of what work has been done on every job, covering the size of rebore of cylinders, the regrinding of crank-shafts, the out of place alinement of the crank-shaft, to take care of the replacement of timing gears, etc.

I wish to take up a very important factor in connection with successful motor maintenance and that is, proper grade of oil to be used. It is impossible for an operating company on the Atlantic Seaboard to recommend the proper grade of oil to a company operating the same make of units in another territory; this you must work out for yourselves. We have coaches of the same make and model operating in two territories under different conditions and remote from each other, and we secure better results by using two different grades of oil.

I have had the question put up to me as to which was the best grade of gasoline. This is also a question that will be necessary for you to work out yourselves. One make of gasoline will give better results in the same make of vehicle in one territory than in another and work out just the opposite in a different type of vehicle.

Owing to the great area covered by our operation, and owing to the fact that we are tying up at a great number of isolated points, it was necessary to develop a system of records and reports so that we could check up on the companies at these isolated points doing mechanical work and servicing for us; this we have accomplished, I am more than confident, for it is impossible for a unit to go over its greasing or oil change period more than 24 hours before we catch it. If a unit goes by these periods and does not show up on the daily report, we get in telephonic communication with the company involved informing them of the fact and follow it up with a call from a member of the mechanical supervision to see that our instructions are complied with.

Our whole operation in regard to tires is being run on a guaranteed mileage basis, the contracts being signed with the

Fisk Rubber Company covering the Rhode Island and Massachusetts divisions and the United States Rubber Company covering the Connecticut division. I am not qualified to give you the figures on our tire mileage, especially at this time, for the mechanical department does not handle these figures, and for another reason, we have not done the mileage where the figures would be of advantage to you, but from my personal observation, I feel sure that regardless of the fact that motor coaches are undertired, you should get from 18,000 to 26,000 miles out of your tires.

The back shops of The New England Transportation Company at Providence will take care of the major overhauling of the internal combustion engines of the gas rail-car equipment of the New Haven Railroad system.

[In presenting the paper, Mr. Swentzel added the following material not included in the formal paper. Editor.]

It was necessary, not only from a maintenance standpoint but from an operating one as well, to group our different fleets; in so doing we were able more economically to stock substores not only at our shops other than Providence, R. I., but also at remote points where we must rely on public shops. This system also makes it possible to train our mechanics, handling equipment on certain routes, on one particular make of unit and has a tendency to eliminate a great deal of abuse of equipment by operators. Where this is done we have noticed a decided decrease in repairs, caused by mishandling. We were somewhat handicapped for the fact that our patrons on one route insisted on a certain type of unit, while on others they wanted an entirely different type.

In the operation of motor coaches, the assignment of equipment should be the proper one from the beginning; do not begin an operation with a six-cylinder coach if a four-cylinder will handle it. Educate the public to a six-cylinder unit and you will have great difficulty in satisfying them with a four-cylinder. It is generally believed that you can operate a four-cylinder coach more economically than a six-cylinder one. This is a fact if the route is suited for a four-cylinder unit, but if not, a six-cylinder unit will perform more satisfactorily as well as more economically.

We have now reached the point where the present mechanical personnel in the back shop at Providence may be retained intact all the year round; a condition that is very desirous, as we have at all times the same well trained force, which means efficiency and economical operation, and above all, the employees are contented and satisfied.

We devote a great deal of time and study to necessary experiments in trying to rectify the chronic troubles we have with our units. I assign certain employees to make a thorough study of the troubles we are experimenting with each make of unit, with a view of working out, in our own way, ways and means to remedy them. I do not ignore the recommendations of the manufacturer by any means, but I do make a thorough study of the operation of each make and use their recommendations as a basic for our experiments. The manufacturers do try to help us in every way possible and I would like to see their engineering departments keep in closer touch with the mechanical departments of the large operating companies.

I have been asked on numerous occasions since my visit to Montreal if the railway mechanics adapt themselves to work on internal combustion engines. We tried it out. I know several other roads did, and we had no success. The automotive trained mechanic is a man who lacks the discipline that the railroad mechanic has in his training, but the railroad mechanic is used to rougher work and has more leeway, for instance, in the fitting of bearings than the automotive mechanic. Consequently, it is a great deal more satisfactory to take men who have had a little automotive training and train them than it is to take the railroad mechanic and try to make an automotive mechanic out of him. Five railroads have had the same experience. The mechanical personnel of the New England Transportation Company is 100 per cent automotive mechanics.

Report on Automotive Rolling Stock

C. E. Brooks
Chairman

In order to secure information on the present use of automotive rail cars on Class I railroads, a general inquiry has been made regarding the size, power and age of all such equipment. In addition, statements have been secured from some twenty railroads known to be large users of rail cars, giving detailed information as to costs of operation for the calendar year 1926, reliability of service and general operating experience.

Summary of Data from Class I Railroads

Number of Cars—The number of cars listed in the replies totals 332, of which 189 are mechanical drive, and 133 electric drive. This type of equipment was originated in 1905, and had a steady growth until 1915, after which there was a period of inactivity until 1921, when renewed interest was shown, and from that time onward there was a rapid increase in the number of cars, the number being trebled from 1921 to 1926.

Transmission—The number of mechanical drive cars was approximately double that of the electric drive cars until 1925, during which year the number of mechanical drive cars did not increase at the prevailing rate, and it appears probable that by the end of 1927 the number of electric drive cars will equal or exceed that of the mechanical drive cars. Some of the reasons for this are to be found in the greater reliability and serviceability of the electric models, simplicity of control and of double-end operation.

There are also a few storage battery cars which were included under the electric drive cars. There is a general tendency at the present time to convert the storage battery cars to gasoline electric drive. There is one experimental hydraulic transmission in use on the New Haven, but the cost figures on this gear are not indicative of normal operating conditions, because of accident repairs not chargeable to the hydraulic feature. The fuel costs on this car are comparable to those obtained with electric drives, but there is an additional cost for transmission oil which has been high due to occasional leakages.

Horsepower—The average horsepower of the cars over the period 1906-26 is shown in *Fig.* 1.

The power of electric drive cars, as shown, was between 175-200-hp. until the year 1925 when a number of 250-hp. engines were introduced and several railroads put into operation double power plant cars running between 400-500 hp., raising the general average to 273-hp. for this last year. The average horsepower of mechanical cars started out at 200-hp. with the McKeen units, and has varied somewhat erratically due to the fact that in 1912 a group of 60-hp. cars was built, in 1917 a 300-hp. car was put out, and again in 1921-22 small engines were temporarily in

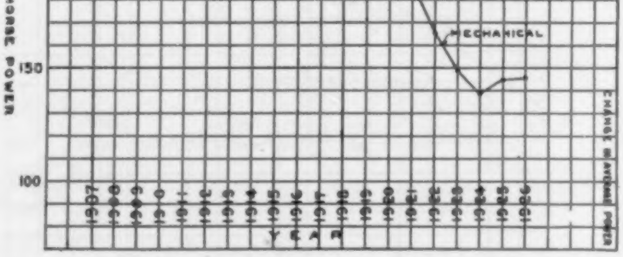


Fig. 1—Average Horsepower of Rail Motor Cars Over a Period from 1906 to 1926

vogue. At the present time there seems to be a tendency to limit the mechanical transmission to cars in the neighborhood of 150-hp. or less. Cars of 180-275-hp. are used with single trailers, and cars over 400-p. are used with from two to three trailers.

Weight-Length—The weight of rail cars is plotted against horsepower in *Fig.* 2 for mechanical cars, and in *Fig.* 3 for electric drive cars. In *Fig.* 4, weight is plotted against length. *Fig.* 2 indicates that the average light weight per horsepower for a single mechanical car is about 350 lb. and that when these cars are operated with trailers the weight per horsepower rises to approximately 630 lb. Electric drive cars average approximately 400 lb. per horsepower operated without trailer, or 700 lb. per

horsepower with trailers. The weight per foot of car length is approximately 750 lb. for small mechanical cars, and 1,100 lb. for large mechanical cars. Electric drive cars average 1,400 lb. per foot of car length, due in part to the increased weight of the transmission and in part to the fact that these cars have in general heavier duty engines and are of more substantial construction throughout.

Power Plant—Nearly all rail cars use six-cylinder engines, the four-cylinder engine being now confined to the smallest type of car, having only 60-70 hp., the one notable exception to this being the four-cylinder and eight-cylinder Diesel engines on the Canadian National, which are rated at 200 hp. and 400 hp. respectively.

Table I—General Average of Rail Car Operating Costs as Reported by Several Class I Railroads
Cents Per Mile

Type of equipment	Mechanical		Electric	
	Single	Trailer	Single	Trailer
Crew	18.69	22.93	18.85	20.79
Fuel	4.59	6.05	10.45	12.10
Lubricating oil	.86	.90	.88	1.00
Supplies / Cleaning / Enginehouse	2.83	3.12	1.66	2.10
Repairs	11.40	10.85	6.31	5.45
Total	38.37	43.85	38.15	41.44
Average daily mileage	101	122	165	203

The limiting cylinder size of modern cars is 7½ in. by 9 in. for gasoline engines, although some of the older gasoline and distillate engines had 8 in. by 10 in. and 10 in. by 12 in. cylinders. Diesel cylinders now in use measure 8¼ in. by 12 in. It is not thought likely that the gasoline cylinder will come back to these very large sizes, but there is no reason to believe that the Diesel engine cannot be used with cylinders as large as may be desired.

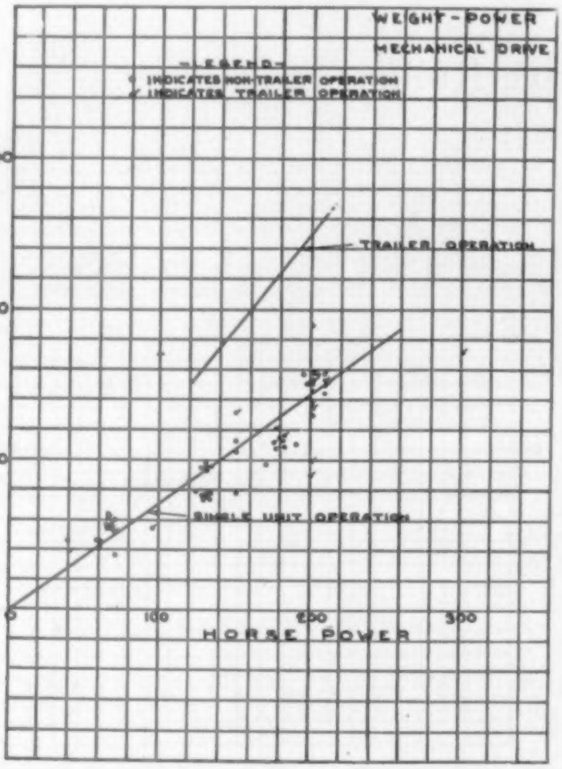


Fig. 2—Weight of Mechanical Drive Motor Rail Cars Against Horsepower

Engine speed of the gasoline engines of 20 years ago was limited to 350 r.p.m., which was increased until in 1925 there were a number of cars operating at 1,600 r.p.m. and 1,700 r.p.m., but the best practice at the present time seems to center around heavy-duty gasoline engines running at speeds from 1,050 to 1,200 r.p.m. The first Diesels put into operation ran at 750 r.p.m. and it seems that this is increasing to a rated speed of 900 r.p.m.

Cooling System—The preponderance of cooling systems are built around cellular radiators mounted either on the front or the side of the car. In some cases the front-mounted radiators are assisted by small over-head radiators which are normally dry, but come into action when the engine speed is increased beyond the idling speed.

A few cars have been built, notably nine on the Canadian National, and two on the N. Y., N. H. & H., in which the radiation is of the finned-tube type mounted on the roof of the car and dependent for air circulation solely on the motion of the car. This has two chief advantages; the first being that the radiation system may be only partially filled when the car is standing, so that the water is confined entirely inside of the car body, thus minimizing the danger of freezing in cold weather;

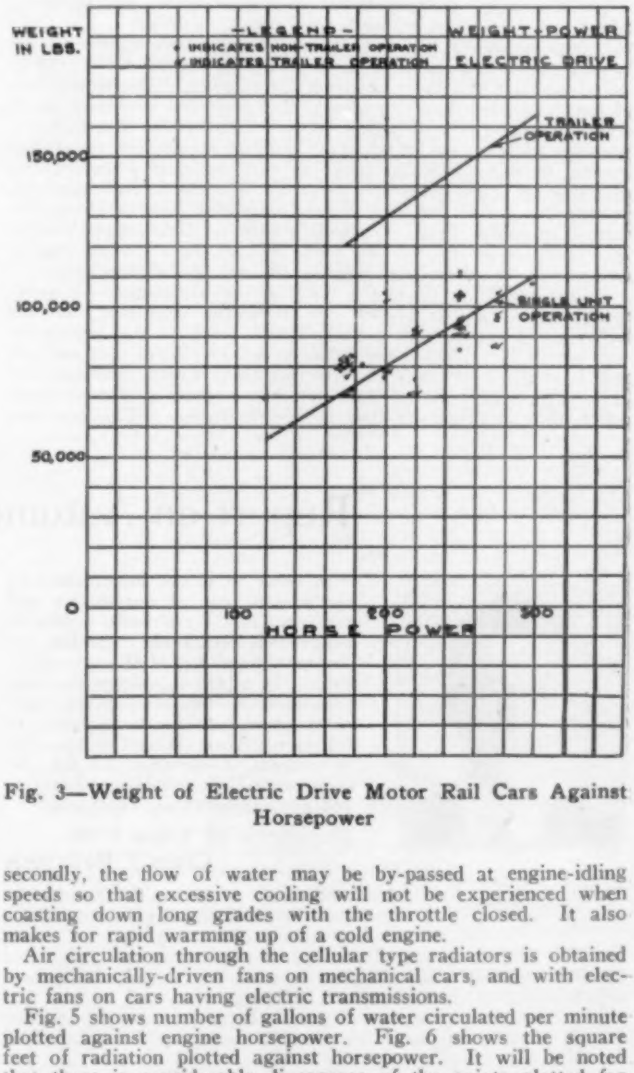


Fig. 3—Weight of Electric Drive Motor Rail Cars Against Horsepower

secondly, the flow of water may be by-passed at engine-idling speeds so that excessive cooling will not be experienced when coasting down long grades with the throttle closed. It also makes for rapid warming up of a cold engine.

Air circulation through the cellular type radiators is obtained by mechanically-driven fans on mechanical cars, and with electric fans on cars having electric transmissions.

Fig. 5 shows number of gallons of water circulated per minute plotted against engine horsepower. Fig. 6 shows the square feet of radiation plotted against horsepower. It will be noted that there is considerable divergence of the points plotted for individual cars, which may be partly explained by the difficulty of measuring these quantities, and by the fact that numerous other variables are involved, a relatively large amount of radiating surface and high water flow being required in those cases where it is thought desirable to operate engines at low-jacket temperatures. This is also true in cases where the engine exhaust manifold is water-cooled. It is stated that a water-cooled exhaust manifold increases the heat flow to the radiators approximately 20 per cent on gasoline engines and 4 per cent on Diesel engines.

Passenger Accommodations—Seat spacing varies from 26 in. to 35 in. center to center, and averages 31 in. Aisle varies from 18½ to 30½ in., with 21 in. the predominating figure. Width of seat per passenger varies from 15¼ in. to 20 in., the almost universal practice being to use 3-2 spacing. There is usually one saloon with dry hopper per car.

Hot water heaters are almost universally used in preference to hot-air type though cars vary so greatly in insulation, use of double windows, location, etc., that the amount of radiating surface varies considerably. Aluminum and finned steel or copper tubes are used to reduce the weight at the system in some cases.

Vacuum fuel feed systems predominate, but a number of cars use air pressure on the main tank, while others use a mechanical pump feeding a gravity tank, with an overflow return to the main tank, and some automatic electric pumps are being tried out. There is room for further development in means for insuring reliability of fuel feed and the removal of foreign matter.

Life of equipment—There is some divergence of ideas regarding the possible life of rail car equipment, and also in regard to the allowances made for this in accounting. It seems to be generally agreed that the car is good for some 20 to 30 years, the power plant 10 to 15 years, mechanical transmissions estimated at from 5 to 10 years, and electric transmissions from 10 to 25 years. Few of the railroads in question, however, have been using equipment a sufficient period of time to speak with authority on this point. The following statement from one of the pioneer railroads on the use of rail cars is, however, highly significant:

Table II—Performance Data

Road	Per cent serviceable days		Miles per total failure	
	Mechanical	Electrical	Mechanical	Electrical
Baltimore & Ohio	....	....	.....	.....
Boston & Maine	74	....	.....	.....
Canadian National	95.3	*81.7	.....	*9,112
Central Vermont	....	96	†15,000	.....
Chicago, Burlington & Quincy	87	....	.....	.....
Chicago Great Western	86	94	9,576	17,207
Chicago, Milwaukee & St. Paul	....	....	.....	.....
Chicago & North Western	66	....	.....	.....
Erie	79.1	95.4	.....	.....
Great Northern	....	....	.....	.....
Lehigh Valley	87.7	97.6	15,951	No failures
New York, New Haven & Hartford	73.3	93.1	11,570	38,900
New York Central	83.4	....	6,555	.....
New York, Ontario & Western	....	....	.....	.....
Northern Pacific	....	....	.....	.....
Pennsylvania	85.7	91.4	24,070	48,235
Reading	94.5	83.6	2,873	8,722
Seaboard Air Line	....	....	.....	.....
Southern Pacific	70.5	....	37,428	.....
Union Pacific	89.1	....	22,724	.....

*Diesel Electric. †Storage battery.

This railroad has cars which have been in daily operation for 20 years, and are now in practically as good condition as when put into service. Of 29 cars now operating, two have been in service nearly 21 years, five nearly 20 years, and all but 10 have been in service over 15 years.

The mileage performance over the total number of years would be difficult to ascertain, but it is a fact that most of our cars have passed the million-mile total, with some of them well along in the second million cycle.

Seven of the original 10 motor cars have been removed from service. These, however, were built during the early experimental days of the rail cars, and were of a different construction from those produced a short time later. The matter of obsolescence has not effected our cars as minor changes have been made from time to time, bringing them up to date, although these changes have not disturbed the original construction more than superficially.

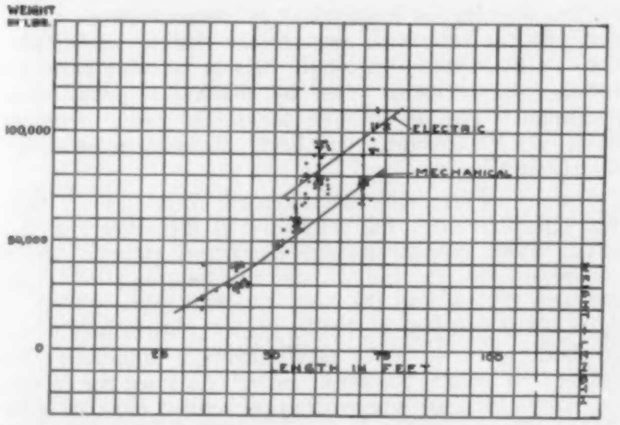


Fig. 4—Weight of Motor Rail Cars Against the Length

Class of service—The majority of the rail car operations are in branch line service, although several of the western railroads use single cars on main line local work. The double power plant cars operating with two and three trailers on the Seaboard and Lehigh Valley lines also handle main line local traffic.

The daily average mileage of all schedules submitted is 148 miles per day per car. The longest daily mileage shown on several railroads runs between 300 and 400 miles, although on the eastern railroads figures in excess of 200 miles per day are rare.

With very few exceptions, the rail cars are used to replace, rather than to supplement or extend steam service. In many cases rail cars permit continuing runs which otherwise would have to be abandoned.

Crew assignment—Three railroads report a normal crew of three on a single car. Other railroads report two men, this as the usual crew on a single car with an occasional third man when the baggage is heavy. When one trailer is hauled, several railroads operate occasionally with a two-man crew, but the normal crew on a single car and trailer is three men. Three railroads report four-man crews on this combination of equipment when the baggage is heavy or when operating in main line service.

Costs—Typical operating costs of rail car equipment are set forth in Table I. It has been necessary in some cases to condense and group items in order to permit ready comparison. Obviously the age of the cars and the average daily mileage must be given due consideration in making comparisons.

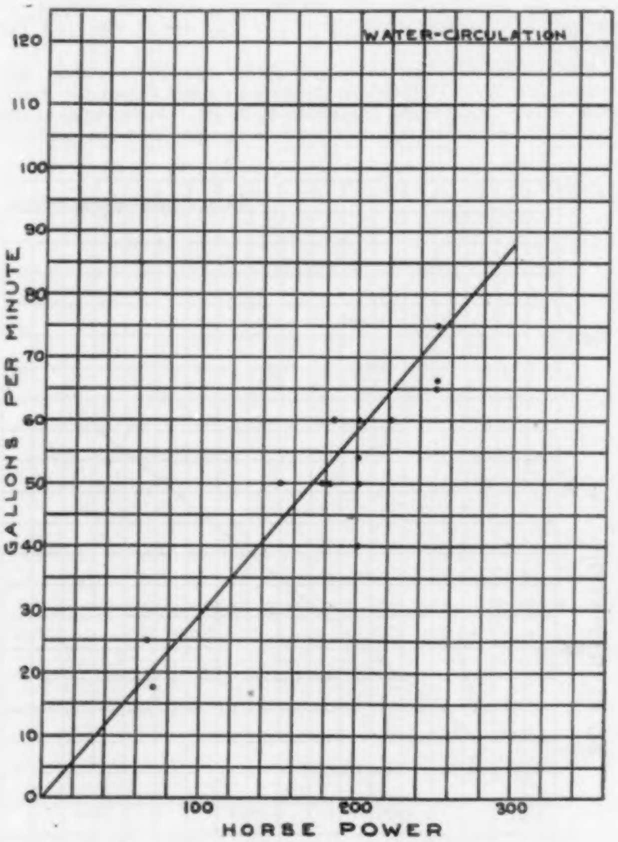


Fig. 5—Number of Gallons of Water Circulated Per Minute Against Engine Horsepower

Fuel—A large majority of rail cars are using commercial gasoline fuels which run slightly better than government specifications, the cost varying between 13 cents and 21 cents per gallon, with an average of 18 cents.

Considerable interest has been shown toward the possibility of utilizing the cheaper low-grade fuels such as distillate and Diesel oil.

The Southern Pacific is using a mixture of one part gasoline to two parts of distillate. The Union Pacific has satisfactorily used straight distillate for a number of years, mostly in large-sized, low-speed engines, this being accomplished through the use of individual carburetors of special design for each engine cylinder. Several other railroads have experimented along these lines with various degrees of success.

The Canadian National has done pioneer work in applying Diesel engines to rail cars and is realizing very satisfactory economies, not only in the cost of fuel per gallon, but in the utilization of this fuel in their engines, securing an unusually high mileage per gallon.

Performance data—There seems to be considerable variation in the methods of recording performance on various railroads, especially with respect to the measure of reliability in terms of miles per detention and miles per total failure. The returns of such information have been gone over and the figures which appear

to have been arrived at on a comparable basis are shown in Table II.

Maintenance—Inspection—Instruction—Replies regarding the organization used for maintenance and inspection of cars have been rather meager due in some cases to the fact that the use of rail cars is usually not of long standing and that no routine shopping methods have been evolved. In most cases, the repairs are apparently taken care of directly where the cars tie up, while on a few railroads, special shops have been equipped into which rail cars are run for heavy overhaul work. Inspection is usually taken care of by especially qualified gasoline engine men in connection with the local maintenance forces. The instruction of operators in the case of newly-acquired equipment is by the manufacturers' representatives, and thereafter by the gas rail car inspectors or road foremen. It is agreed that a thorough education of personnel and the efficient and smoothly-working organization constitute most important factors of the rail car problem.

Public opinion—The expressed public opinion is almost uniformly favorable, although in the case of some antiquated equipment, which has proved unreliable in service, public opinion has been adverse—or, merely tolerant. It appears that the public is

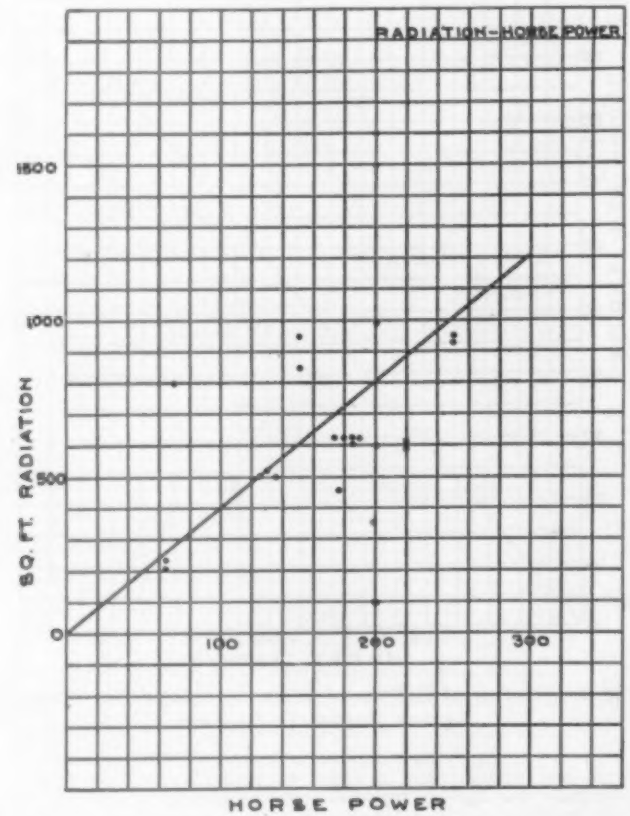


Fig. 6—Square Feet of Radiation Against Horsepower

much more favorable toward the large cars which appear more like regular equipment, and in which case the rather rough operation of gears and clutches has been eliminated by the use of electric drives.

Scope of application—The replies to the questionnaires are rather non-committal respecting the possible scope of application of rail cars, and in general refer directly to the present application of rail cars on the respective lines, so that railroads operating only single cars on branch lines express themselves as believing that this is the only suitable application, whereas railroads which have operated large cars with single or multiple trailers in main-line local service seem to consider this a satisfactory application.

Although in Table I, it is shown that the direct operating expenses of gas rail cars are distinctly less than those of branch line steam service, this does not constitute the entire saving, for by the use of automotive equipment it has frequently been found possible to avoid the expenses due to the maintenance of coaling and water stations, turn tables, ash pits, etc., and in many instances it has permitted the rearrangement of runs and the concentration of facilities in relatively few modern enginehouses and the closing up of small outlying houses, or limiting their use to mere shelters for gasoline equipment. In some other cases, due to the double-end operation of electric cars, the turning of locomotives, and the numerous incidental switching operations have been eliminated permitting economies in forces and shorter terminal layovers. The actual values of these somewhat intangible savings are not easily obtained, but they are not inconsiderable and it is probable that as railroads become more familiar with the possibilities of the rail car they will find increasing opportunities for their benefical and economical use, as there is a larger field for rail cars than that which has been exploited.

This report is signed by C. E. Brooks (chairman), Canadian National; B. N. Lewis, Minneapolis, St. Paul & Sault Ste. Marie; F. P. Pfahler, Seaboard Air Line; F. K. Fildes, Penna.; A. H. Fetters, Union Pacific, and D. L. Bacon, New York, New Haven & Hartford.

Discussion

C. E. Brooks: We hope, in order to be of some real service to you next year, if we are continued as an active committee, to take hold of one or two of the real problems which we merely have been able to indicate here, study them thoroughly, get the experience of those roads that are making an attempt really to analyze these problems. One problem is fuel. When you come to check up the Class I railroads and find out what kind of fuel they are using, get their distillation curves, know what economies they are getting, know just what they are doing with that fuel, how they are absorbing the waste heat, how they are absorbing the exhaust heat, you have to come to the conclusion that automotive equipment in many cases is being treated very much like the automobile that the general public secures. I would not like to say that none of the railroads who have given us the information in the questionnaire are making a real study. We have secured reports from two or three of the Class I railroads indicating that for the past 10 years a deep study has been made and that very successful operation is the result.

Mr. Demarest: Most of us have passenger service that does not pay. In our own territory, which is a thickly-populated territory, we have had to reduce some of our service to the point where the city commissions would not let us go any further, not that the service we are maintaining is economical or remunerative. It is not. So the problems, even in the thickly settled portions of the country, can only be met in some cases by reduced losses rather than by making a profit from operation. The automotive car is the only thing we have, which apparently will bring about more economical results.

Insofar as reliability is concerned, there has not been any question about the reliability of the three cars we have. Their average mileage was pretty close to 50,000 last year. One car ran without any failures at all. One had one failure, and the other one had three. That, in spite of the fact that we haul a trailer continuously which is about twice as heavy as the average automotive car trailer. It weighs 93,000 lb. light. As I see the record, we have one place where an improvement must be made and that is the maintenance cost of the gasoline unit itself. A more reliable situation there would have resulted in considerably greater economy, not that the situation created failures. It took constant attention.

In our operations we have used a gasoline engine unit rated at 275 hp. In our experience with the trailer we have been hauling, it is not powerful enough. We have been getting maximum power out of that engine and some of our high gasoline engine costs have undoubtedly been brought about by the fact that the gasoline unit has been worked pretty well up to the limit. It seems then that a higher powered unit would be more economical.

The service which you put these cars to is never re-

stricted to hauling the weights that you start out with. As you develop your service, your traffic or transportation people will always find the way to get additional loads behind the automotive car, so we have got to allow sufficient margin to work it at an economical point.

The question our vice president has got into his mind is that insofar as public opinion is concerned in riding these automotive cars, that the vibration and the engine noise does not attract patronage; but we have not lost any business.

As a matter of fact, the vibration is considerable, and some method of making a more comfortable car insofar as noise is concerned ought to be given attention.

I believe the committee ought to take up a uniform system of reporting costs of operation. I have tried to analyze the results of our own performance with the reports from quite a number of different railroads. I can't find any two reports that are made up on the same basis, so that when I come to the final analysis, train-mile costs, I am not at all sure that any comparison we make is representative at all. Some uniform schedule for reporting operating and maintenance costs, taking into consideration the depreciation rate you are going to charge off for equipment, should be outlined.

The cars have been operating not only on branch service but on main-line service, running right in with high-speed passenger and freight trains.

Mr. Dunham: We have found that in several instances vibration has been a considerable cause of adverse comment from the public. I presume most of you have noticed the recently-promulgated instructions of the Post Office Department calling for soundproofing of the partition between the engine room and the mail compartment. Evidently, they have got the same idea.

Mr. Brooks: Perhaps the most interesting thing I can tell you about the operation of the Canadian National oil cars is that they are not being operated in red figures. They are being operated in black figures and they are one of the best paying things that we have done yet.

This perhaps answers in one way the remark that an engine had not yet been developed which would operate rail cars except by gasoline. One of the large roads west of Chicago is and has been operating for years on distillate. It is distillate, I will admit that, which from a study of the distillation curve is almost good enough to put into a tank and run an automobile on, but at the same time it is distillate and it is being bought at distillate prices. While we have gone through a lot of trouble with our oil engines and at times have been discouraged we feel that we have an engine that will operate on fuel oil and operate successfully.

Insofar as the cost per mile for fuel is concerned, with Canadian prices, we can operate a 110,000-lb. car on approximately a 30-mile per hr. schedule, for about 10½ cents a mi. less with fuel oil than with gasoline. When those figures are transposed to American prices, the ratio is a little different; in other words, there is less spread because your gasoline costs are lower.

It makes no difference what size power plant is in your car, if it is 200 hp. you will haul all the 200 hp. will haul; if it is a 350 hp., it will do just the same, and that 350 hp. unit is not going to be left on a 200-hp. job. Mechanically, I would like to have a 350-hp. unit to do a 200-hp. job, because I could sit back and pretty nearly nothing would ever go wrong, but no railroad will make money that way. When you have got a 350-hp. engine you want to get 350-hp. to make money.

There are two or three things wherein we do not compare very favorably yet with gasoline-operated engines. Our engines make more noise and have a little more vibration.

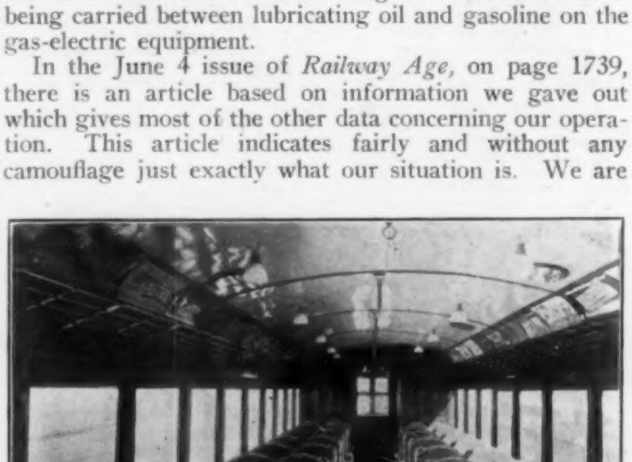
The six-cylinder engine in this car at the present time was built in Scotland and has a speed of 800 r.p.m. It is exactly the same engine as is being built by Westinghouse at South Philadelphia. The electrical equipment was developed by Westinghouse, and while they were hesitant in starting to throw in the resources of their great engineering department with this high-speed oil engine venture, I think that from what they have seen, they realize today its great possibilities.

Our first attempt with a four-cylinder engine led us into certain troubles. The first trouble was difficulty with the heads. The intense heat coupled with heavy detonations both with fuel oil and with distillate in a gasoline engine, resulted in cracked heads. A cracked head will allow jacket water to leak slowly through the head to build up on top of a tight piston, and of course you all realize just exactly what is going to happen when you turn that engine. That trouble, I think, has been entirely overcome, and when we started to analyze just how to overcome it, we found how little many of the gas engine builders knew about the circulating water system. Many of them have built and sold power plants which would not operate the circulating system at the idling speed. Let me indicate to you here now that whether it is an oil engine, a distillate engine or a gasoline engine, one thing that you must be able to do is to cool the engine at idling speeds. That means that the pump equipment must be of such a design as to really overcirculate at top speed.

We started in using a light fuel oil, of about 32-34-deg. Baumé gravity. We have found from experience that the heaviest oil that we can handle under the existing weather conditions will give us the best results. The heaviest oil means the cheapest oil. This is not a crude oil engine, it is a fuel oil engine.

The lubricating oil problem has been serious and I would judge from the statistics that came in answer to our questionnaire that the lubricating oil situation has also been serious with the gas-electric cars. Generally we use about the same amount of oil. We carry about the same ratio between lubricating oil and fuel oil as is being carried between lubricating oil and gasoline on the gas-electric equipment.

In the June 4 issue of *Railway Age*, on page 1739, there is an article based on information we gave out which gives most of the other data concerning our operation. This article indicates fairly and without any camouflage just exactly what our situation is. We are



B. & M. Rail Motor Car Equipped with Highway Motor Coach Type Seats

not satisfied, as I indicated to you before, with our percentage of serviceability. We are going to maintain reasonable serviceability, and I think that with the steps that have been taken by the American manufacturers today we are going to be able to buy a highly-efficient light weight and reasonably cheap oil engine unit that will meet all the conditions required.

The report was accepted and the committee continued.

Report of Committee on Car Construction

W. F. Kiesel, Jr.
Chairman

Following the practice of recent years, your committee on Car Construction has delegated the various assignments given them to subcommittees, whose reports follow.

Trucks

In last year's report of progress the program of tests was stated in detail, and the loadings of the Symington and American Steel Foundries machines tabulated.

It may be pertinent at this time to call attention to some important differences in method of loading on the two machines, and, for ready reference, these loads, which were given in detail in the report of progress made last year, are repeated herewith:

40-Ton Frames

Symington Machine	American Steel Foundries Machine
Vertical Load:	Vertical Load:
Maximum, 75,000 lb.	Maximum, 78,000 lb.
Minimum, 30,000 lb.	Minimum, none.
60 applications per minute.	50 applications per minute.
Transverse Load:	Transverse Load:
9,000 lbs. in and out.	10,500 lb. in and out.
12 applications per minute.	100 applications per minute.
6 in each direction.	50 in each direction.
*Center Twist Load:	*Center Twist Load:
6,000 lbs. right and left.	7,000 lb. right and left.
2 applications per minute.	50 applications per minute.
One in each direction.	25 in each direction.
Length of lever arm 38½ in.	Length of lever arm, 58½ in.

50-Ton Frames

Vertical Load:	Vertical Load:
Maximum, 100,000 lb.	Maximum, 100,000 lb.
Minimum, 40,000 lb.	Minimum, none.
60 applications per minute.	50 applications per minute.
Transverse Load:	Transverse Load:
12,000 lb. in and out.	13,000 lb. in and out.
12 applications per minute.	100 applications per minute.
6 in each direction.	50 in each direction.
*Center Twist Load:	†Center Twist Load:
8,000 lb. right and left.	8,500 lb. right and left.
2 applications per minute.	50 applications per minute.
One in each direction.	25 in each direction.
Length of lever arm, 38½ in.	Length of lever arm, 58½ in.

The following loads are the same for all frames:

End Twist:	None.
1 in. throw of crank.	
12 end twist per minute.	
6 in each direction.	
Center Impacts:	None.
2,090 lb. weight 6¼ in. fall.	
12 impacts per minute.	
6 right and left.	
End Impacts:	None.
12 impacts per minute.	
6 right and left.	

(*) The center twist load applied either to spring plank or bolster guide of the frame.
(†) The center twist load applied only to spring plank.

Vertical Load

The American Steel Foundries machine alternates between no load and maximum load, while in the Symington machine the minimum load is never less than 40 per cent. of the maximum. The number of applications per minute does not materially differ in the two machines.

Transverse Load

The difference in actual load is not great, but the American Steel Foundries machine applied the load 50 times per minute in each direction, while the Symington machine makes only six applications in each direction per minute.

Center Twist Load

There is not much difference in the intensity of load, but, in the American Steel Foundries machine, the load is applied 25 times per minute, in each direction, with a lever arm 58½ in., while in the Symington machine the lever arm is only 38½ in., with one application per minute, in each direction.

These comments cover both the 40-ton and 50-ton tests.

End Twist

The end twist load is obtained by rocking the stub axles on which the frame is supported in each direction, thereby inducing end twist forces.

Center Impact

The weight of 2,090 lb., falling 6¼ in., is allowed to strike 12 times per minute, in addition to the normal vertical load,

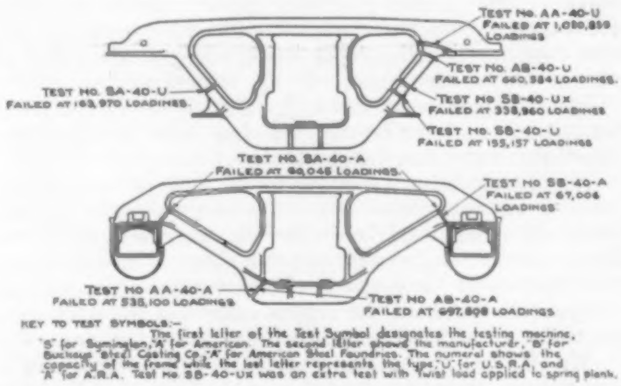


Fig. 1—Test of 40-Ton U. S. R. A. and A. R. A. Type Frames on Symington and American Fatigue Testing Machines

and this center impact is timed to strike at the instant of maximum stress with all the other loads.

The various loads on both machines were applied either through calibrated springs or through accurately measured weights. The proper sequence of loading was determined by various systems of cams and levers.

Both machines were developed for the purpose of greatly exaggerating service conditions, in order to develop in a short

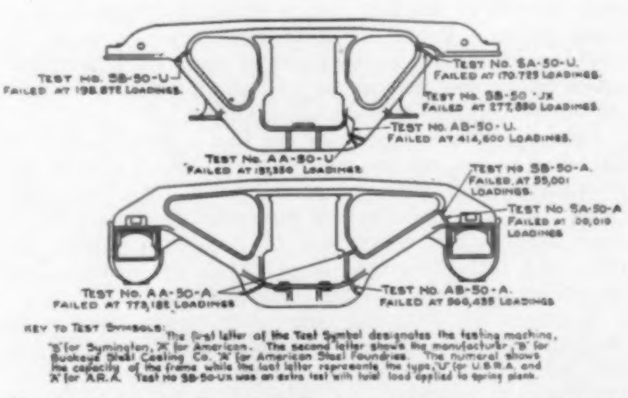


Fig. 2—Test of 50-Ton U. S. R. A. and A. R. A. Type Frames on Symington and American Fatigue Testing Machines

time by tests failures that might require years to develop in service. There is no way of determining the exact comparison between the stresses in the machine and stresses developed in actual service, but it is a fact that frames may be tested to destruction in a few days on either one of these machines, that will give satisfactory service over a period of years without failure.

Scope of Tests

The tests comprised the following:

Fatigue tests on Symington side frame testing machine.

Fatigue tests on American Steel Foundries side frame testing machine.

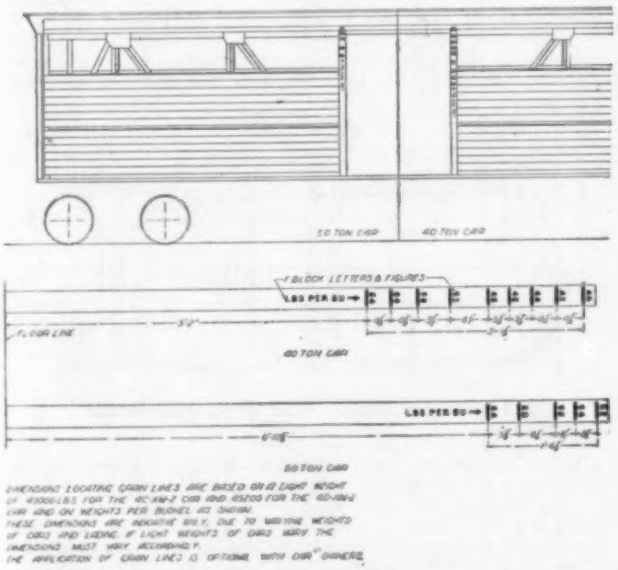


Fig. 3—Proposed Uniform Stenciling of Grain Lines in Box Cars

Static tests on Baltimore & Ohio tension testing machine of 600,000 lb. capacity.

Tension tests from coupons attached to frames, turned to standard 0.505 by 2.00 in. size, were made at Baltimore & Ohio test bureau.

Chemical analyses from tension test coupons were made at Baltimore and Ohio test bureau.

Photomicrographs of annealing coupons attached to frames were made at Baltimore and Ohio test bureau.

One frame of each type and capacity, furnished by each of the two manufacturers, was tested on the Symington side frame testing machines. Corresponding frames were tested on the American Steel Foundries machine and on the B. & O. tension testing machine. In addition two U. S. R. A., type frames, one 40-ton and one 50-tons capacity, manufactured by the Buckeye Steel Castings Company, were tested on the Symington machine, with the twist load applied to the spring plank.

Preliminary to Tests

Each frame was given a test symbol and marked so that the identity would not be lost. The following examples will indicate the method of marking the test frames.

Test Symbol	Testing machine	Manufacturer	Capacity Tons	Type
SB-50-U	Symington	Buckeye	50	U.S.R.A.
AA-40-A	Amer. Steel Foundries	Am. Steel Foundries	40	A.R.A.
MB-50-A	Baltimore & Ohio	Buckeye	50	A.R.A.

Observations and Tests

The height of all springs used for applying the various loads were checked at regular intervals during the tests, in order that all frames might be subjected to the same intensity of stresses. After the tests were started, the machine was run as continuously as possible until failure occurred. The frames were closely observed while under test and notes made regarding cracks, indications of stress, etc. The corresponding number of loads was also noted.

The loads employed in the various testing machines were the

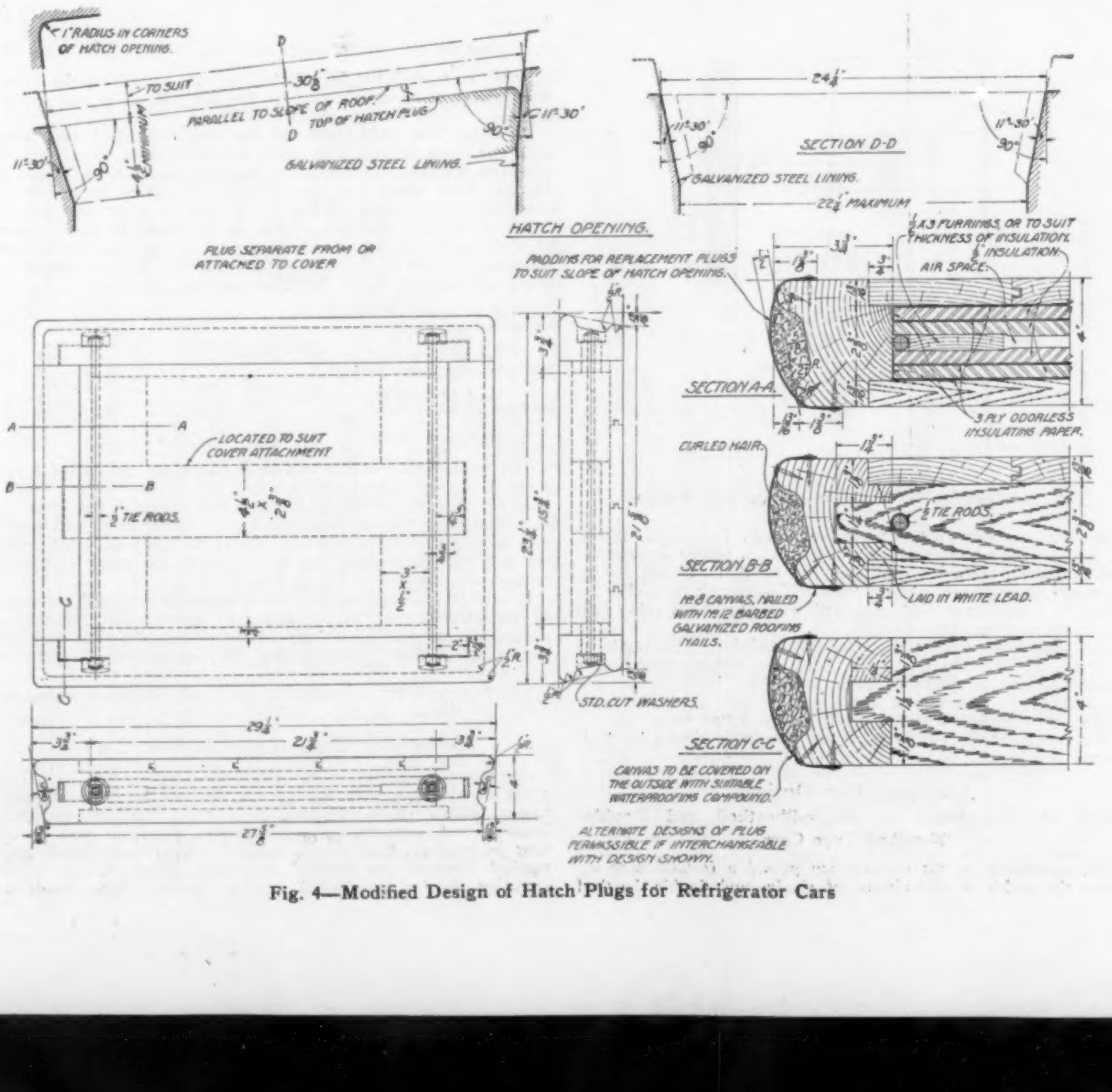


Fig. 4—Modified Design of Hatch Plugs for Refrigerator Cars

same as customarily used by the Symington Company and American Steel Foundries for testing frames of similar capacity. Strain gage readings, to determine the stresses in the various members of the frames, were taken only on the frames tested on the American Steel Foundries machines.

The U. S. R. A. frames were fitted with tie bars and journal boxes for all tests. The box bolts were kept tight throughout the progress of the tests.

After failure, the frames were examined and notes made regarding the extent and location of cracks, as well as the condition of the metal where failure occurred. The tested frames are being held for disposition.

Results of Tests

A complete report of the data secured in all these tests has been presented by the subcommittee to the Committee on Car Construction. This report is so voluminous, however, that it is not incorporated completely in this progress report. The results of the tension tests, the chemical analyses, the fatigue tests, and static tests, are also given. In addition, diagrams are included which show the location of the final failure on each of the frames tested in the American Steel Foundries and Symington machines, together with the number of the machine cycles at which each frame failed.

Summary

The foregoing data and diagram show a rather wide variation in the results of the fatigue tests, but results of the static tests are quite uniform. There are several hundred thousand frames of each design now running, which have been in service several years, with few failures reported, which indicate that, so far as strength is concerned, both designs are satisfactory for general service. In fact, the committee has knowledge of only one failure of the A. R. A. design.

At the junction of the tension and compression members, where the strength of the frame is most severely tested on the Symington machine, the A. R. A. frame failed sooner than the U. S. R. A. type, which the subcommittee feels is due, at least in part, to the support received from the strap on the U. S. R. A. frame, and the fact that the box bolts were kept tight during the tests, which condition might not always obtain in service. The committee feels, however, that the A. R. A. design can be materially strengthened at this point without any appreciable increase in weight and cost, and will undertake to develop this during the coming year.

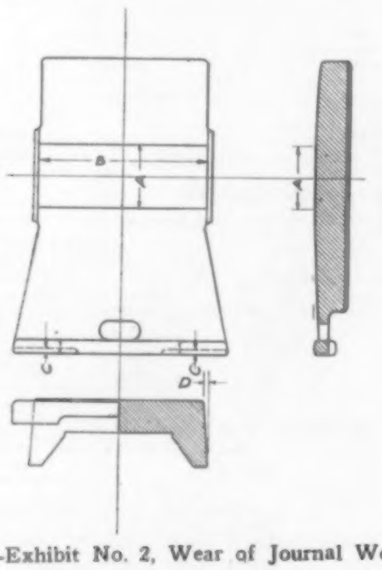


Fig. 5—Exhibit No. 2, Wear of Journal Wedges

The tests also developed certain inequalities in strength at different parts of the U. S. R. A. frame, but as this design employs separable journal boxes with box bolts, while the standard of the association is the integral box type, the committee will confine its future study to the latter type.

The report of the subcommittee on Trucks is signed by J. J. Tatum (chairman), John Purcell and A. R. Ayers.

Standard Car Design

Width of Underframe of Single-Sheathed and Double-Sheathed Type Cars

The committee on car construction passed a resolution to increase the width of underframe of single- and double-sheathed cars from 8 ft.-9 in. to 8 ft.-9⅜ in., for the purpose of eliminating shims in the construction of double-sheathed cars. This is a minor change, but requires a revision of the drawings. It will not affect the serviceability of the car in any way, and will have little effect on interchangeability; neither will it increase the cost.

In the case of the double-sheathed box car, this change will eliminate the shims shown on Plates 136, 138 and 140 in the Supplement to the Manual. This represents 16¾ lb. of steel per car. There also will be a reduction in the weight of certain parts, such as door post and post connections, etc., shown on Plates 125, 126, 135, 137, 139, 141, 142, 144 and 174, as well as a slight saving in length of certain bolts, all amounting to 15¼ lb., to which should be added a saving of 6¾ lb. of lumber in the side sill nailing strips.

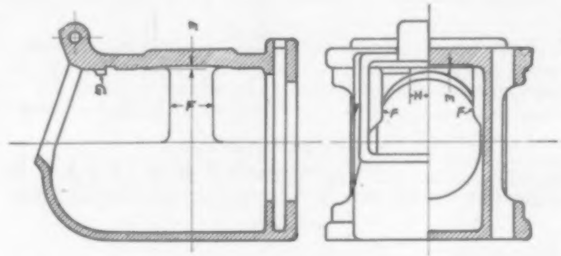


Fig. 6—Exhibit No. 3, Wear of Journal Boxes

Increasing the width of underframe ⅜-in. over-all will add a corresponding length of material to the cross-members shown on Plates 199 to 205, inclusive, and Plate 207. This addition amounts to 8¾ lb. per car. Summarizing the above, we have

Reduction of metal	32 lb.
Addition of metal	8¾ lb.
Net reduction of metal	23¼ lb
Reduction of wood	6¾ lb.
Total net reduction in weight	30 lb.

Labor costs will not be affected, except in case of the items eliminated, shown on Plates 136, 138 and 140, as it will not be necessary to cut and punch these fillers.

Widening the underframe of the single-sheathed car, with post end construction, will result in an increase in weight of the parts affected, similar to the increase noted above, which is 8¾ lb., from which may be deducted the saving in weight of door posts, amounting to 5¾ lb., giving us a net addition of 3 lb. A further reduction of 1¾ lb. is caused by modification of door guide castings, and, inasmuch as the end lining and flooring will be ⅛ in. longer, the increase in the weight of wood will amount to 10 lb. Summarizing, we have:

Increase in weight of underframe	8¾ lb.
Reduction, door posts	5¾ lb.
Net addition of steel	3 lb.
Reduction, door guide castings	1¾ lb.
Total addition of metal	1¼ lb.
Addition of lumber	10 lb.
Total net addition in weight	11¼ lb.

The inside width of car will be 8 ft.-6⅜ in., instead of 8 ft.-6 in., or an increase of 10¾ cu. ft.

In the case of the single-sheathed car, having a flat plate, or a pressed plate end modifications to the corner posts will result in a saving of 30¾ lb. per car. Other factors considered under the post end construction not being altered, the result is a total reduction in weight of car of 19½ lb.

It will be noted from the above that the proposed widening of underframe does not penalize the construction relative to weight and cost, but does improve the design of double-sheathed house cars without handicapping the single-sheathed types in any way.

The report of the subcommittee on Underframes is signed by J. T. St. Clair.

Stenciling Grain Lines in Box Cars

A member suggested that a uniform practice for stenciling grain lines in box cars used for grain loading be established. Communications from various roads indicates that some use grain lines marked for oats, corn, wheat, etc., to which such grains may be loaded. One uses a method which shows grain lines marked "pounds per bushel" to which grains having corresponding weights per bushel may be loaded. Some roads do

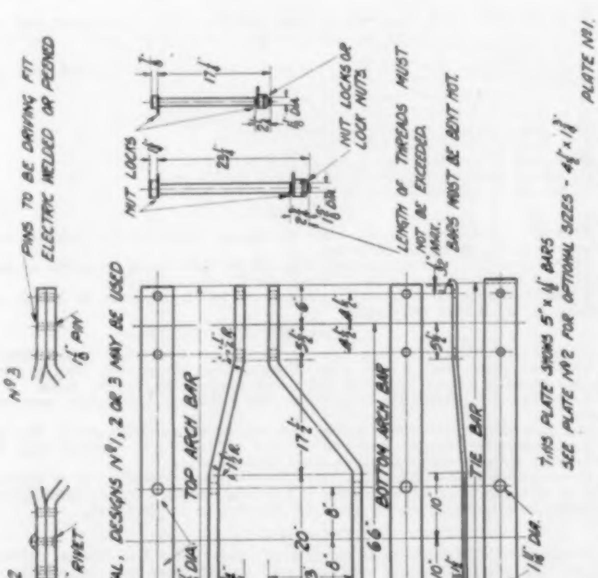


Fig. 7—Plate 1, 5 in. by 1½ in. Arch Bars for 40-Ton Trucks

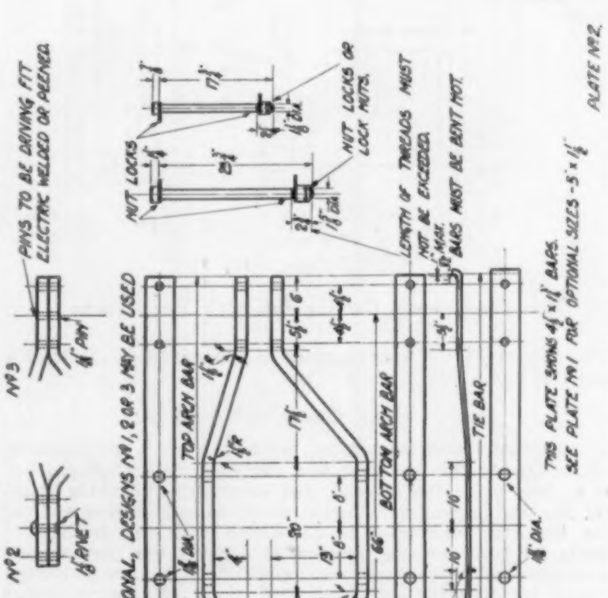


Fig. 8—Plate 2, 4½ in. by 1¾ in. Arch Bars for 40-Ton Trucks

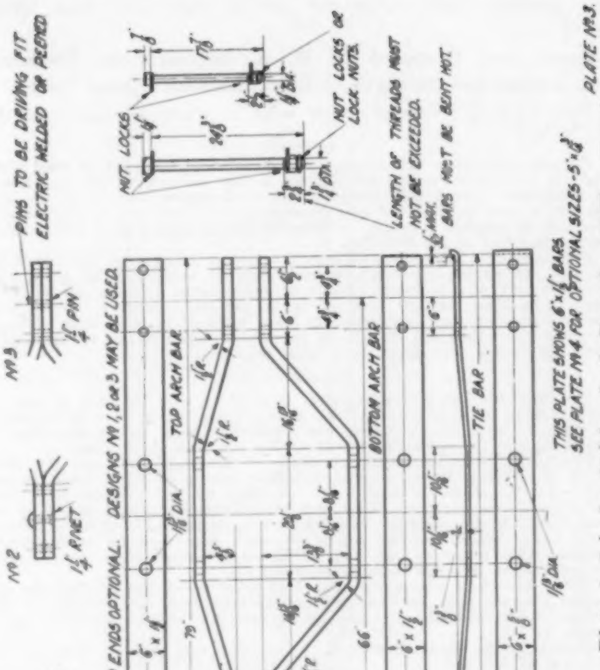


Fig. 9—Plate 3, 6 in by 1½ in. Arch Bars for 50-Ton Trucks

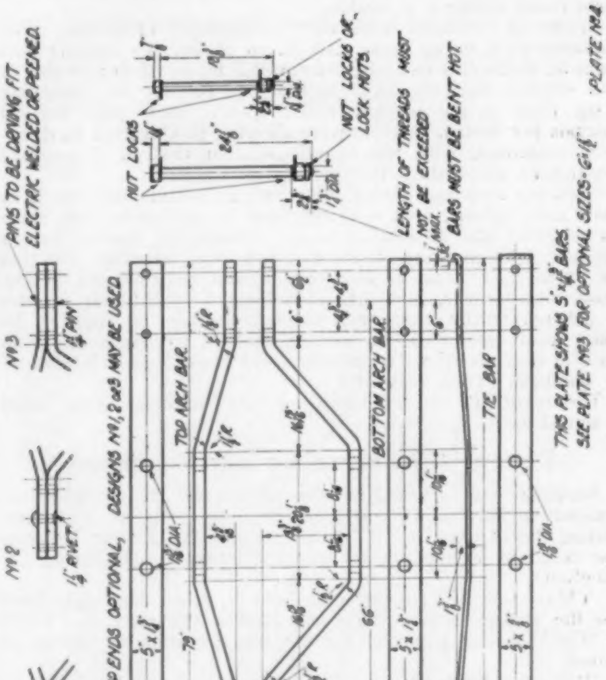


Fig. 10—Plate 4, 5 in. by 1¾ in. Arch Bars for 50-Ton Trucks

not use grain lines, since grain is weighed at the elevators on these roads before it is loaded.

Grains of the same kind vary considerably in weight. For example, corn varies from 38.5 lb. to 56 lb., per bushel; oats from 32 lb. to 38.5 lb.; wheat from 48.5 lb. to 62 lb.; so that it was decided that the most satisfactory method for stenciling grain lines is the method which shows grain lines marked "pounds per bushel," and drawing showing this method is, therefore, submitted, with the recommendation that, if a standard practice be established, this method be adopted.

Open-top cars are loaded with various commodities, such as coal, sand, gravel, iron ore, etc., and no provisions are made for limiting the amount of such commodities loaded, except the load limit marking on the car, and it is, therefore, felt that the loading of grain in box cars should be governed by the same requirements, and that stenciling of grain lines in cars is not universally necessary, although it may be required by some local conditions, on certain roads. Furthermore, grain lines in cars are of no value unless the grain load is leveled-off or trimmed. (See drawing.)

The report of the subcommittee on Stenciling Grain Lines is signed by A. R. Ayers.

Designating Letters for Car Equipment

Attention was directed to the advisability of changing the designating letters "TS" to evade possible confusion, and eliminating the designation "FT." A study of this subject indicates the criticism is just, hence we recommend the following for adoption:

"TMU"—A car equipped with holders, other than glass lined for the transportation of gas and liquids. (In place of "TS.")

"TW"—A car equipped for the transportation of pickles in brine.

"RT"—Refrigerator cars for transporting milk in bulk.

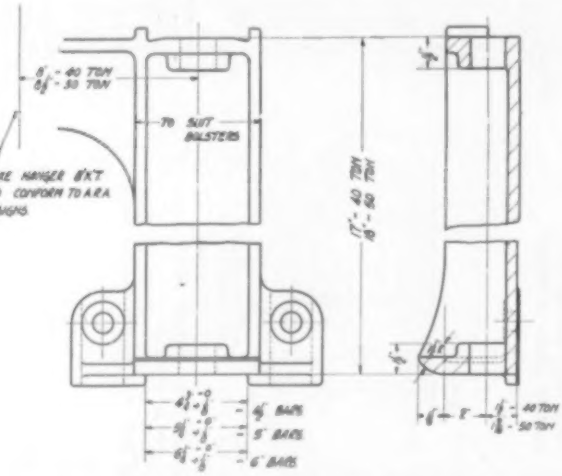


Fig. 11—Column Casting for Arch Bar Trucks

The report of the subcommittee is signed by J. McMullen (chairman) and Ira Everett.

Box Car Ends

In compliance with instructions, we have revised recommended practice specification covering box car ends, shown on pages 7 and 8, Sec. C, of the Manual, and submit the following statement showing present specification, proposed specification, and the more important data used in connection with this revision:

Ends for both new and existing cars have been covered, and the adoption of the proposed requirements will involve no change in ends which have been applied to A. R. A. Recommended Practice house cars.

Although this specification relates specifically to corrugated, reinforced, flat plate, and pressed steel ends of various designs, and in our opinion, it is not practicable to construct a composite end having strength equivalent to the types enumerated, specification for a composite end has been included as an alternate arrangement. Insofar as practicable, the use of this end should be confined to stock cars.

It is our recommendation that the Comparative Statement Showing Present and Proposed Specifications Covering Design and Strength of Steel Ends for House Cars, a portion of which is intended to supersede the specifications now contained in the Manual, be submitted to the members of the Mechanical Division of the Association, in order to provide full information on the proposed specification for use in connection with letter ballot vote.

Present and Proposed A. R. A. Specifications Covering Design and Strength of Steel Ends for House Cars

Paragraphs are numbered in the order in which they appear in the A. R. A. Manual.

Paragraph 1

Present—(1) News cars should have corrugated steel ends or steel plate ends ¼ in. thick, reinforced between corner posts with the equivalent of either two vertical steel braces with a total section modulus of not less than 9; or one vertical and two diagonal steel braces with a total section modulus of not less than 10; or three horizontal steel braces with a total section modulus of not less than 10.

Proposed—(a) Ends for new cars other than refrigerator cars shall be of steel, of either corrugated, pressed plate or reinforced flat plate construction and may be made of one or more pieces. When one piece is used it must be not less than ¼ in. in nominal thickness. When constructed of more than one piece, the lower third of the end must be made in one piece and not less than ¼ in. in nominal thickness and the remainder shall not be less than $\frac{3}{16}$ in. in nominal thickness.

Paragraph 6

Present—(6) The corrugated ends referred to may be made of one or more pieces. If made of one piece, it should not be less than ¼ in. thick. If made of more than one piece the lower third must not be less than ¼ in. thick, and the remainder should not be less than $\frac{3}{16}$ in thick.

Proposed—(b) Flat plate ends shall be reinforced with not less than three steel braces having a total minimum section modulus, when figured independently of end sheet, of not less than 8.4 in.^{3}. When more than three braces are used they must have an individual section modulus of not less than 2.5 in.^{3}. Section modulus may be calculated without deducting rivet holes. When vertical braces are used, they must be symmetrically located about center of end and the distance between their centers must be not greater than 0.2 of inside width of car.

When horizontal braces are used, they must be so located that the distances between their centers, and the distance from top of floor to the center of the bottom brace are not greater than 0.2 of the clear inside height of car.

Remarks—The three present A. R. A. end post sections have a least modulus of 8.40 in.^{3}

The A. R. A. 50-ton Double and Single Sheathed cars have end posts located on 18 in. centers. By use of the factor of "0.2 of the inside width," the maximum distance between end posts for these cars would be:

D/S Car = 103.75 in. x 0.2 = 20.75 in.
S/S Car = 102 in. x 0.2 = 20.40 in.

The A. R. A. 50-ton Double and Single Sheathed cars, when equipped with all-steel roofs, have clear inside height of 8 ft. 7¼ in.

By use of the factor "0.2 of the clear inside height," the maximum distance between braces and between the bottom brace and the top of the floor would be:

103.25 in. x 0.2 = 20.65 in.

Proposed—(c) Corrugated ends shall have a total minimum section modulus of not less than 1.45 times the clear inside height of car in feet. Pressed steel ends, other than those commonly termed as corrugated, shall have minimum strength requirements equivalent to those specified for corrugated ends.

Remarks—The total minimum section modulus for a corrugated end in general use on a car having an inside height of 8 ft. 7 in. equals 12.85 in.^{3}
12.85 ÷ 8.58 = 1.50.

Section modulus for one foot (2 corrugations) of corrugated end in general use:
¼ in plate = 1.74 in.^{3}
$\frac{3}{16}$ in. plate = 1.42 in.^{3}
Clear inside height A. R. A. box cars:
S/S Box Car, Steel Roof 8 ft. 7¼ in.
D/S Steel Frame Box Car, Steel Roof 8 ft. 7¼ in.
D/S Steel Frame Box Car, O. M. Roof 8 ft. 5⅞ in.
D/S Auto Box Steel Roof 9 ft. 3 in.

Paragraph 5

Present—(5) Lining at car ends should be supported at intervals not greater than 30 times the thickness.

Proposed—(d) The unsupported distance between lining supports at car ends shall be not greater than 20 times the lining thickness.

Remarks—Proposed maximum spacing of lining supports is based on present A. R. A. flat plate ends.

Paragraph 2

Present—(2) New cars may have the following alternative arrangement: Three or more steel braces, two of which run diagonally, with a total section modulus of not less than 12½, and wood lining 1¾ in. thick.

Proposed—(e) Stock cars may have the following alternative arrangement:

Not less than four steel braces, two of which run diagonally, having a total minimum section modulus of 12.0 in.^{3} Section modulus may be calculated without deductions for rivet or bolt holes.

Remarks—While it is not felt that the specified composite end is equivalent in strength to an all steel end, it has been included in the specification in order to provide an end suitable for application to stock cars.

Paragraph 3

Present—(3) To concentrate strength at a point near floor line on vertical center line of car, diagonal braces should extend from the center sills to the side plates, and not from the bottom corner to the ridge.

Proposed—Wood sheathing must be not less than 1¾ in. thick. The vertical braces shall be symmetrically located about center of end and the distance between their centers must be not greater than 0.27 of the inside width of car. The diagonal braces must extend from the bottom of the vertical braces to the intersection of end plate and corner post.

Remarks—The four present A. R. A. end post and brace sections have a least section modulus of 12.1 in.^{3}

The A. R. A. 50-ton Single Sheathed car has two end posts located 27 in. center to center. By use of the factor "0.27 of the inside width of car," the maximum distance between centers of vertical braces for this car and for the proposed A. R. A. stock car would be:
S/S Car = 102.27 x .27 = 27.5 in.
Stock Car = 102.5 x .27 = 27.7 in.

Paragraph 4

Present—(4) The attachments for the braces and the members to which they are attached must be sufficiently strong to realize the full strength of the braces.

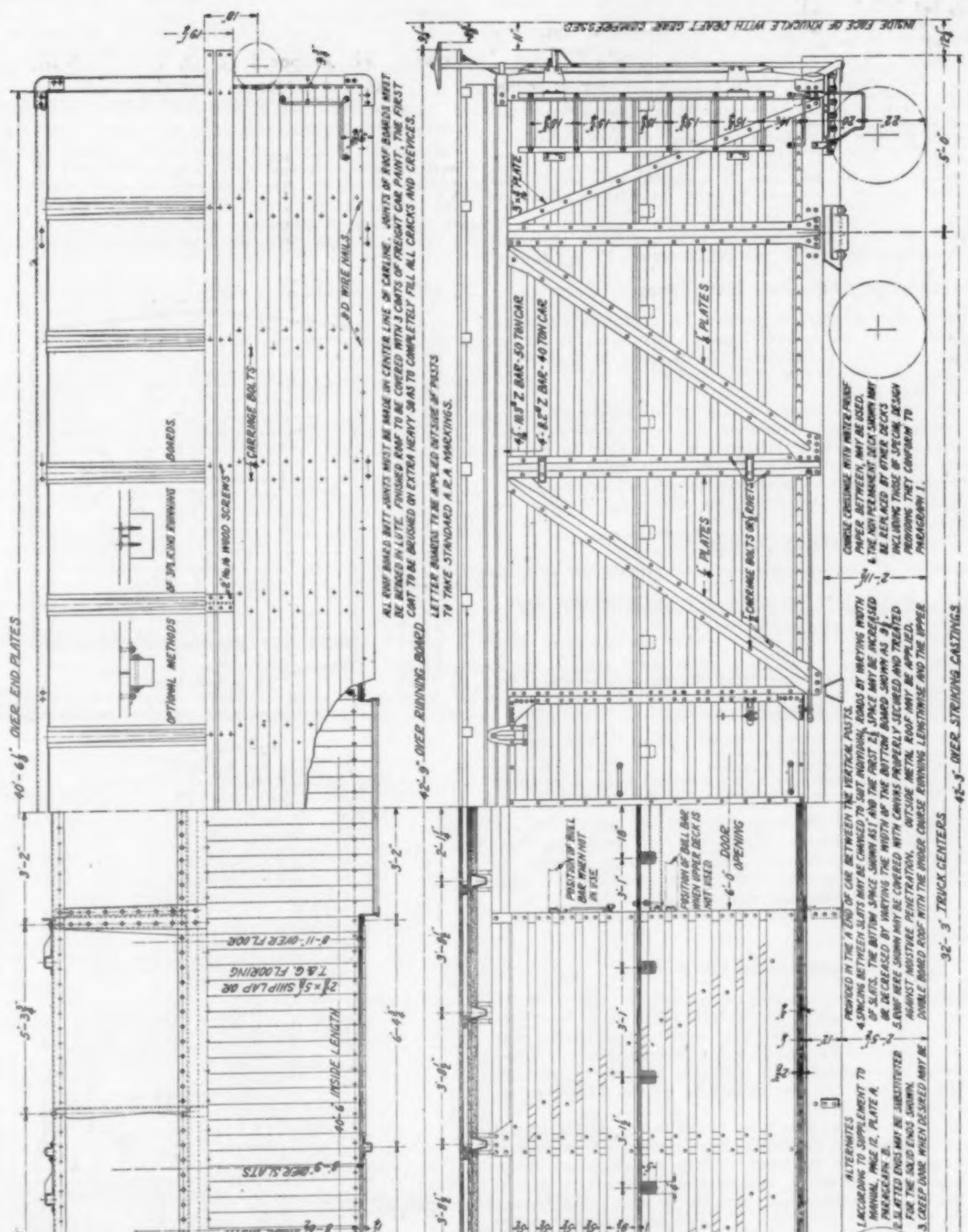


Fig. 12—Proposed Standard 40-Ton and 50-Ton Stock Cars

Proposed—(f) The connections for end braces and the members to which they are attached must be sufficiently strong to realize the full strength of the braces.

(g) The attachment of the end to the car structure should be consistent with the strength of the various parts involved.

PARAGRAPH 7

Present—(7) On house cars (other than refrigerator cars) with steel underframes or steel center sills, having a center sill area of not less than 24 sq. in., when an end requires repairs consisting of new posts and braces, the ends shall be replaced with ends specified for new cars, this to be done by or under the direction of the car owner.

Proposed—(h) Ends on house cars (other than refrigerator cars) with steel underframes or steel center sills, having a center sill area of not less than 24 sq. in., that require repairs consisting of new posts and braces, should be replaced with ends equivalent in strength to those specified for new cars. This work to be done by or under the direction of the car owner.

The report of the subcommittee on Box Car Ends is signed by W. O. Moody (chairman), W. A. Newman, P. W. Kiefer.

Hatch Openings for Refrigerator Cars

Letter ballot circular dated September 10, 1925, was submitted and approved. This letter ballot, under item 4, approved, as recommended practice, a design of hatch plug and slope of hatch opening for refrigerator cars as shown in Fig. 1 accompanying the letter ballot.

Complying with the request of a number of private refrigerator line companies, your committee has since reviewed this design, and recommends that the drawing be changed to embody a number of features that will make the design more acceptable to those interested. This design is shown on accompanying drawing, and, for ready reference, the following features are referred to:

Hatch Opening

1—The slope on all four sides has been made uniform and shown as 11° 30′.

2—A filet of 1 in. radius has been placed in each corner of opening.

3—The minimum depth of slope has been changed from 4¼ in. to 4½ in.

4—An outline of plug in position has been indicated.

5—Extension of sloping sides of hatch opening has been shown so as not to restrict designs of hatch frame.

6—Note reading: "Slope of roof 1⅛ in. in 12 in.," has been removed.

7—Note has been added reading: "Plug separate from or attached to cover."

Hatch Plug

1—Note has been added reading: "Alternate designs of plug permissible, if interchangeable with design shown."

2—Corners of framing show a ½ in. radius.

3—Plug was made 4 in. deep allowing for additional ½ in. of insulation.

4—Contour of framing has been modified to take the hair packing.

The changes indicated above tend to improve the design and render it the more acceptable for general use. It is therefore, recommended by your committee that the design adopted as Recommended Practice be modified to incorporate the changes shown in the drawing accompanying this report.

The report of the subcommittee on Hatch Openings is signed by John Purcell.

Automobile Cars

Preliminary designs of unrestricted as well as restricted 40- and 50-ton double-sheathed automobile cars have been developed. As referred to in the 1926 report, letter ballot was submitted to develop if 40- and 50-ton, unrestricted or restricted, cars are desirable, together with different side door openings, also whether the restricted car should be of the 40-ft.-6-in. or 50-ft.-6 in. inside length.

Result of letter ballot was very inconclusive, and a special committee was appointed to visit a large number of automobile manufacturing plants, in conjunction with the National Automobile Chamber of Commerce, and, as soon as necessary data is compiled, the sub-committee will then be in position to further analyze this matter, in order that a supplementary letter ballot may be prepared on more definite propositions. After result of letter ballot is known, design will be made accordingly for final submittal.

The report of the subcommittee on Automobile Cars is signed by O. S. Jackson (chairman), and John Purcell.

Method of Attaching Brake Beam Hangers to Side Frames

At the 1926 annual meeting, the subcommittee's report on the above subject was submitted and all recommendations were later presented to letter ballot vote, and were finally adopted as recommended practice, effective March 1, 1927.

As instructed, the subcommittee referred the general design of the bracket to George G. Floyd, chairman of the Manufacturer's Truck Committee as a result of which slight refinements were made in the design of the bracket, to accommodate standard foundry practices. As further requested, the width of slots for the brake hanger, on each side of the center bearing of the bracket, was increased from 1⅛ in. to 1 3/16 in., without changing the length of the center bearing, in order to accommodate Schaefer loop hangers.

The report of the subcommittee on Method of Attaching Brake Beam Hangers is signed by A. H. Fetters (chairman), Ira Everett, and K. F. Nystrom.

Journal Wedges, and Limiting Gage

Your subcommittee has inspected nearly 2,000 journal boxes and journal wedges, and endeavored to select cars which have been in service from 10 to 20 years in order to ascertain the maximum wear. The inspection covers the journal boxes and journal wedges from various types of freight and passenger car trucks most commonly used at present.

Your committee finds that the wear on top of the wedge, in

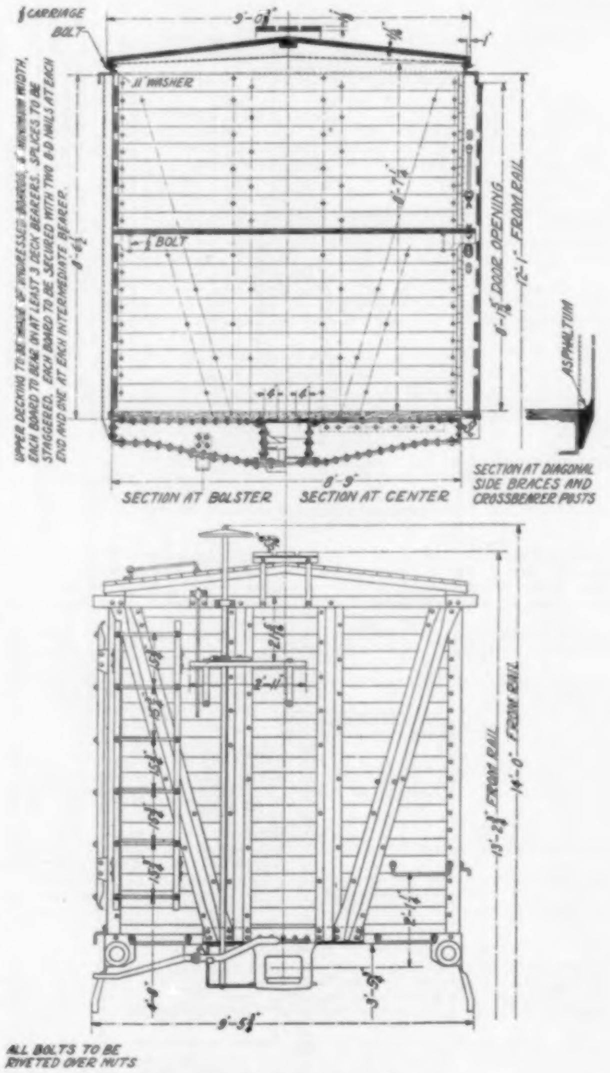


Fig. 13—End Elevation and Cross Section of Proposed Standard Stock Cars

form of a flat spot, dimension *A*, Exhibit 2, varies from zero to, in isolated cases, 6 in. The wear on the sides of the wedges, dimension *B*, Exhibit 2, is negligible, but end wear is common. The end wear of the journal wedge takes place at the front, indicated by dotted lines, *C*, Exhibit 2, where it comes in contact with the two lugs projecting from the roof of the journal box. This wear, between the front end of the journal wedge and the lugs on the roof of the journal box, contributes considerably to excessive lateral clearance, causing the inner face of the journal box to wear against the hub of the wheel.

As stated, the wear on the sides of the journal wedge is negligible, but some dropped-forged wedges are made with tapered sides. This is objectionable, particularly if the wedge is wider at the top than at the bottom, as it has a tendency to tilt when brakes are suddenly applied. Your committee recommends a limiting dimension, *D*, for the slope of the wedges.

The wear of journal boxes, from the wedge at top, dimension *E*, and on the sides at *F*, was not appreciable. A slight wear was noticeable on the sides of the box at *F*, from the journal brass, but not sufficient to justify placing a limit for wear at this point. The lugs in the roof of the box, marked *G*, do not provide sufficient bearing area for the end of the wedge, and, therefore, it is recommended that the length of these lugs be increased by reducing dimension *H*.

In view of the above, your committee recommends to condemn wedges as unfit for further service, when the following limits are reached:

(a) When the length of the flat spot on the top of the journal wedge exceeds the nominal diameter of the journal. Example: Wedges for 5 in. by 9 in. journal will be condemned when the flat spot exceeds 5 in. in length.

(b) Wedges to be condemned when the length over-all, measured at the contact surfaces, is more than 3/16 in. below the nominal length. This may be restored by welding.

The following changes in the journal box wedge are recommended:

(1) Width at the bottom of new wedges to conform with present standard. The width of the wedges at the top may be 1/16 in less over-all than at the bottom.

(2) The length of lugs in the roof of the journal boxes to be increased on each side to within 1/4 in. of the center of the box.

(3) Correct Manual to show all guides inside of journal box with a flat surface in place of cored-out surface.

Attached hereto is exhibit No. 1, showing the contour of the top of wedge and the amount of wear for a given length of flat spot. Exhibits Nos. 2 and 3 show journal wedge and journal box, respectively, with dimensions used.

The report of the subcommittee on Journal Wedges is signed by Ira Everett (chairman), J. McMullen, R. H. Dyer, and K. F. Nystrom.

Standard Blocking for Cradles of Car Dumping Machines

Your subcommittee was requested to make a study of the standard blocking provided for car dumping machines, to establish what changes, if any, were necessary to better arrange them, so the blocking would insure better protection to the cars, against damage, which are required to be unloaded on these machines.

The committee has not had sufficient time to go into the matter as thoroughly as it expects to. It has, however, obtained drawings from various roads, showing the method of blocking made use of. The information develops that the existing standard blocking provided for these machines is about as satisfactory as can be provided for the reason that it is seldom that machines are built exactly alike. Also it is rarely, if ever, that all the same build of cars are used on any one machine. For this reason, the blocking is found to vary on each machine, so as to suit local conditions.

To establish a standard that can be used on all machines and under all conditions—at least for the time being—appears to be impossible. Such an arrangement may be possible if all machines could be built of one design, and all cars in service were alike. Necessarily, for the want of time to go into the matter further, and to make more definite recommendations, this report can only be considered a progress report.

(A drawing, not shown, of the present standard blocking accompanied the report.)

The report of the subcommittee on Blocking for Car Dumping Machines is signed by J. J. Hatum (chairman), J. A. Pilcher, and J. McMullen.

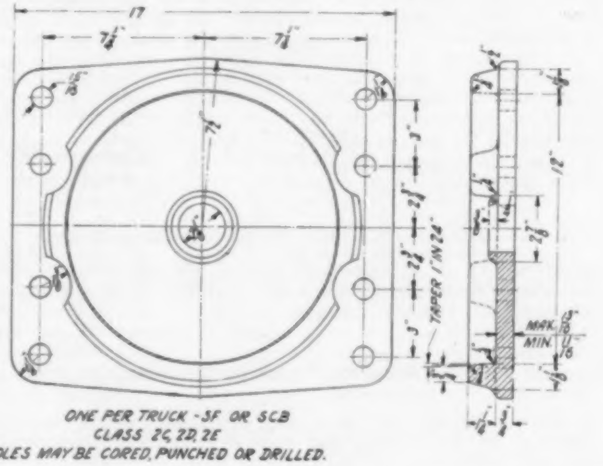


Fig. 15—Proposed Truck Center Plate for Separable Center Plate Bolster

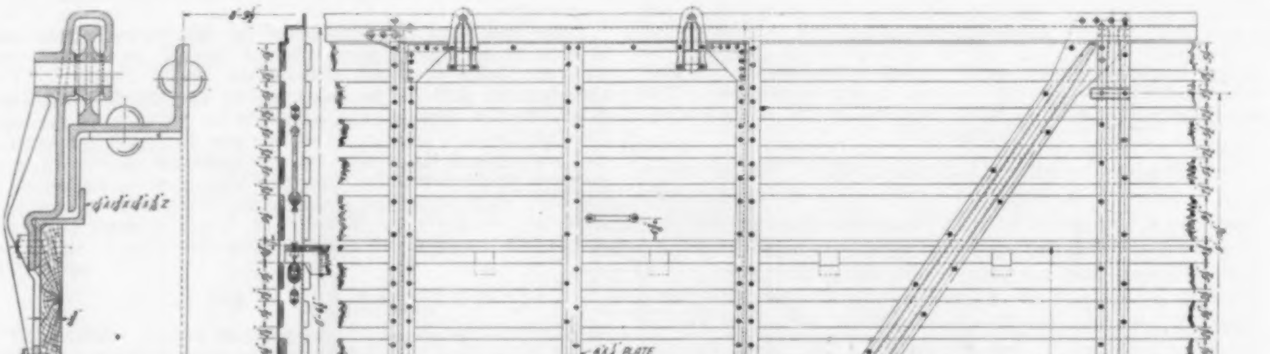


Fig. 14—Side Door Arrangement for Proposed Standard Stock Cars

Design of Refrigerator Cars

Your subcommittee was instructed to prepare drawings covering a steel-framed refrigerator car, with A. R. A. underframe and trucks. Cross-section of such a refrigerator car, based where possible on box car design and falling within the standard clearance limits, was submitted for criticism. This cross-section indicated a distance between bulkheads of 33 ft.-2⅝ in., together with total inside length of car of 39 ft.-11⅞ in.

The roads represented by members of the subcommittee are now building a number of steel-frame refrigerator cars, closely to the proposed A. R. A. design, which will develop the builders' views in regard to construction features and place the sub-

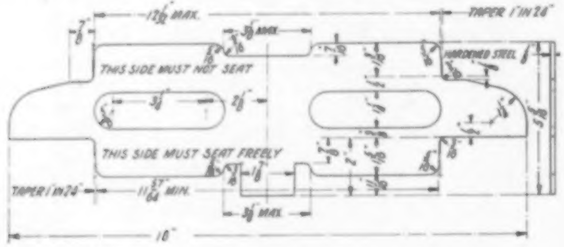


Fig. 16—Proposed Truck Center Plate Gage

committtee in position to perfect the design during the construction of these cars, and before submitting final detailed drawings.

Your subcommittee feels that a preliminary design with sufficient daawings to show the general construction of the car might be submitted to the Refrigerator Car Owners' Organization, as well as to the members of the committee on Car Construction, and thoroughly criticized and discussed before the detail drawings are prepared.

The report of the subcommittee on Refrigerator Cars is signed by A. H. Fetters (chairman), J. T. St. Clair, and C. H. Harding.

Arch Bar Trucks

Arch bar truck failures have been sufficiently extensive to warrant the adoption of revised standards for maintenance. The new sections are based, as far as practical, on the stress analysis of the A. R. A. recommended standard cast steel truck frames, excepting that the limitation for combined stress has been set at 20,000 lb. per sq. in.

On account of the diversity of sizes of arch bars now in common use, it is thought advisable to recommend two sizes of strengthened arch bars, one of increased width over the present A. R. A. standard, and one of increased thickness.

It is unanimously recommended that:

1—The dimensions of arch and tie bars to be used for maintenance of existing trucks shall be:

Arch Bars: Either 1¾ in. by 4½ in. or 1½ in. by 5 in. for 40-ton trucks; 1¾ in. by 5 in. or 1½ in. by 6 in. for 50-ton trucks.

Tie Bars: ⅝ in. by 4½ in. or ⅝ in. by 5 in. for 40-ton trucks and ⅝ in. by 5 in. cr ⅝ in. by 6 in. for 50-ton trucks.

2—When, for any cause, it is necessary to renew the bottom or inverted bar of a truck, both inverted bars on that truck should be changed to the recommended standard, such change to be at owner's expense, in accordance with Sec. A, Interchange Rule 17. Should the new A. R. A. inverted arch bars prevent the reapplication of top arch bars and tie straps, then top arch bars and tie straps of new A. R. A. design shall be applied, billing to be in accordance with Sec. A, Interchange Rule 17.

3—Column castings should be of malleable iron or cast steel and conform to the general design and dimensions as covered by Exhibit A.

4—The shear value of arch bar connections above the journal box should be increased by one of the optional methods shown on plates 1, 2, 3 and 4.

5—The shear value of journal box and tie bar connections should be increased by turning up the end of the tie bars, as shown on plates 1, 2, 3 and 4.

6—Journal box and column bolts of the better grade of steel should be considered, and this question should be referred to the Specifications Committee, for advice as to whether an improved specification can be provided that will give a material of greater shear and tensile strength without increasing danger of heads breaking off.

The report of the subcommittee on Arch Bar Trucks is signed by W. A. Newman (chairman), C. B. Smith, and J. McMullen.

Single Sheathed Box and Stock Cars

Your subcommittee on Design of Single-Sheathed Box Car was instructed to prepare a design of 40- and 50-ton stock cars, utilizing standard box car details as far as possible. No report, other than to indicate that the designs were under way, was made last year. This design, now presented for approval, is covered by the two cuts attached, one showing the general arrangement of car, the other the arrangement of side door. These drawings represent both the 40- and 50-ton cars; the only difference between the two being in the trucks, and the thickness of top side Z-bar, corresponding with those of the single-sheathed car.

Details of the single-sheathed box car were utilized as far as possible, and the single-sheathed car underframe, side posts and braces, with necessary modifications in punching of the latter, have been incorporated. The difference in punching and in door posts is due to using slatted sides and stock car type doors.

Safety appliances conform to those of the single-sheathed cars. It should be understood that any modifications approved by the Association for the single-sheathed car will automatically also cover the stock car.

Where legal or railroad requirements compel variations in arangement, such permissible alternates are covered by notes. Special alternates are covered by notes, but it should be understood that the general rules covered by Plate A of the Specifications for A. R. A. box cars, dated October 7th, 1926, also apply to this car.

These two plans clearly indicate the detail construction, and as soon as we receive your approval thereof, we will proceed with the detail drawings, making the design complete. The classifications will be as follows: 40 Ton Stock Car, Class 4CSI; 50 Ton Stock Car, Class 4DSCl.

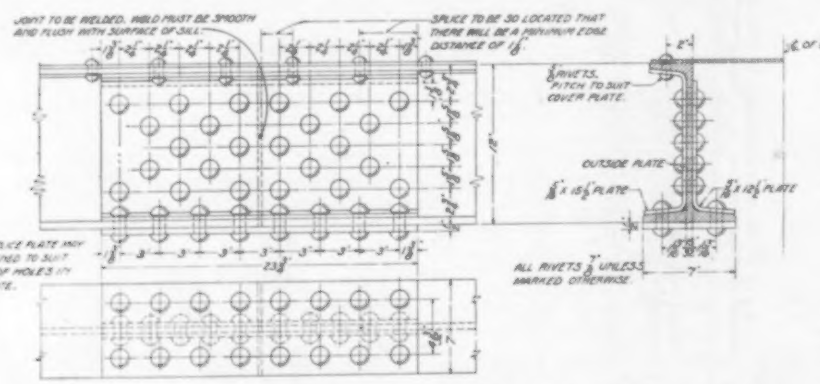


Fig. 17—Proposed Standard Method of Splicing A. R. A. Center Sills

The report of the subcommittee on Design of Stock Cars is signed by C. R. Harding, (chairman), and W. F. Kiesel, Jr.

Summary

Trucks

The subcommittee points out variations in results of tests on the two machines, due to the different methods of applying load, which requires further study to determine which corresponds with maximum service conditions.

This progress report, as given, indicates that side frames bought on specifications adopted as Recommended Practice in 1926 give satisfactory service; that the possibility for improvement in the A. R. A. side frame design should be carefully determined, which we will do.

Standard Car Design

The detail report on width of underframe gives good reasons for increasing this width by ⅜ in., which increases the inside

width of single-sheathed cars from 8 ft.-6 in. to 8 ft.-6¾ in. This should be submitted to letter ballot for adoption, and, if adopted, the drawings will be changed accordingly.

Lettering and Marking

This is mainly a transportation matter, and the subcommittee endeavored to conform to what was indicated to be the best arrangement for uniformity of practice. This item should be submitted to letter ballot.

Designating Letters for Car Equipment

The changes recommended will serve to clarify discrepancies, so that misunderstandings will be reduced. This should be submitted to letter ballot.

Box Car Ends

This report should be carefully studied. The interest is to make the rules such that there is greater assurance against damaged ends. It should be submitted to letter ballot.

Hatch Openings for Refrigerator Cars

A great amount of work has been expended on this subject. The various interests involved are in agreement. Although this would appear to be a minor feature, the standardization of a design to be used on all cars is of great importance. It should be submitted to letter ballot.

Brake Beam Hangers and Supports

The modification reported may be considered a provision for 1/16 in. greater clearance. It is not an actual change in design; and it is suggested that the change be approved without submitting it to letter ballot.

Design of Journal Wedges, and Limiting Gage Therefor

The changes recommended are intended to insure more uniformity, and should be submitted to letter ballot. If adopted, the gages shown in Sec. B, page 23, (1926), of the Manual, should be made to conform. The gages shown in Sec. B, pages 17 to 21, inclusive, (1926), which are obsolete, should be eliminated, and gages shown on pages 22 and 23 should be advanced to standard. This should also be referred to letter ballot.

Design of Truck Center Plate

Breakage of the rim of collar around the king pin hole has been reported to be on the increase. Several railroads have reduced the height of this rim to ⅜ in., and changed the contour, to provide necessary clearance under all conditions. This is shown on accompanying diagram, and is submitted for your approval by letter ballot, after which the center plate drawings and gages therefor should be revised. An affirmative vote will carry with it your authority to make the necessary changes in the Manual.

Splice for A. R. A. Center Sills

To facilitate repairs to standard A. R. A. center sills, the committee presents accompanying drawing of a standard splice, for use at any point between bolsters, one splice, being permitted in each center sill. This should be submitted to letter ballot.

Truck Springs

Although there is no report to submit this subject is under investigation in co-operation with manufacturers. Progress has been made and a number of tests are under way. Prospects for an interesting report later are good.

Arch Bars

Greater loads now carried in cars have materially increased arch bar failures, hence it will reduce cost of maintenance to gradually replace existing arch bars with those of larger section, as proposed, which are more commensurate with other designs. This should be submitted to letter ballot.

Self-Clearing Hopper Cars

By special Letter Ballot, the height of hopper cars was fixed at 10 ft.-8 in. Since this was definitely fixed, there has not been sufficient time for the subcommittee to make a design subject to the new conditions. They report progress.

Stock Cars

Every effort was made to bring this stock car design up-to-date, and to permit special acceptable preferences of the different roads. There is one feature, the length of car, which cannot be compromised. There are advocates for various lengths, from 36 ft.-0 in. up. Investigation discloses the fact that the controlling factor is the spacing of loading chutes, that this spacing varies materially in different localities, and a large number of such chutes are in a condition to require rebuilding anyway. Hence, the more important factor will be to adopt a standard length that can be kept standard for the longest time. This, in the judgment of your committee, justifies using the box car length which permits using the single-sheathed box car framing design for new cars, also permits converting box cars into stock cars and vice versa. It then permits spacing chutes at a standard distance to suit the standard car. This should be submitted to letter ballot.

Lumber for Cars

Specifications for lumber have been discussed with and suggestions made to the committee on Specifications and Tests for Materials. Consistent efforts have been made to agree on standard sections that will conserve lumber, be easy to obtain, and that will be suitable for the various requirements for cars. A few minor differences will yet have to be adjusted, after which we can submit report.

Possible Patent Infringements

The status of patents in connection with A. R. A. car design has been raised frequently. The designs of A. R. A. cars were, therefore, submitted to the Eastern and Western Railroad Associations by member railroads, a voluminous report has been received, and is now being carefully studied. The reports point out many features which, under certain conditions, may infringe existing patents. We have reason to believe that our study of the reports, based on a knowledge of the state of the art, will eliminate a large number if not all of these possibilities of infringement. Where it is believed that an item is not entirely clear of infringement, this will be recorded on the drawing of the detail involved.

The report of the Committee on Car Construction is signed by W. F. Kiesel, Jr., (chairman), Pennsylvania Railroad System; A. R. Ayers, New York, Chicago & St. Louis; O. S. Jackson, Union Pacific; C. L. Meister, Atlantic Coast Line; J. McMullen, Erie; John Purcell, Atchison, Topeka & Santa Fe; W. O. Moody, Illinois Central; J. A. Pilcher, Norfolk & Western; P. W. Kiefer, New York Central; C. B. Smith, Boston & Maine; S. O. Taylor, Missouri Pacific; Ira Everett, Lehigh Valley; W. A. Newman, Canadian Pacific; G. S. Goodwin, Chicago, Rock Island & Pacific; J. J. Tatum, Baltimore & Ohio; L. K. Sillcox, Chicago, Milwaukee & St. Paul; E. B. Dailey, Southern Pacific.

Discussion

Mr. Kiesel: The subject of widths of underframe of single-sheathed and double-sheathed type cars, which will also be applicable to stock and refrigerator cars was submitted to letter ballot and was passed.

Mr. Ayers: Since the report on the stencilling of grain lines was formulated, we have had notice that the grain committee in the Twin Cities and the Contact Committee of the Northwestern Regional Advisory Board are working on this question in connection with the Minnesota state law, and it is suggested that any definite action be deferred. Our legal department advised me that the Minnesota state law could not govern interstate commerce, although their law applies to any cars coming into the state.

Mr. Dunham: About a year ago, the C. & N. W. decided that it would eliminate grain lines in old and new cars, practically for the reasons indicated in the report.

A. H. Fetters (U. P.): On the subject of attaching brake beam hangers to the side frame, the subcommittee inspected about four or five hundred cars, and were pretty well convinced that there was one part of our cars that called for some sort of standardization. We found a heterogeneous variety of styles of hanging brake beams. Some of them were the old styles left over from a great many years ago. They were pretty poor. We found all stages of wear and dilapidation, in fact, the subcommittee's inspection saved at least one derailment from a dropping brake beam.

The Chairman: With regard to the item covering the method of attaching brake beam hangers to side frames and on which you have just received report, Mr.

Kiesel would like to have that particular item discussed.

Mr. Dunham: We have recently had a question by our legal department as to the use of the slot for the brake beam hanger in using a loop hanger, whether we could use a U-shaped retainer or whether to use two separate split keys. The department has indicated to us that in order to avoid any chance of infringement that we should use the two keys.

Mr. Smart: The same question was asked for the C. N. and I was able to advise our legal department that we have been using that since 1916.

Mr. Kleine: It appears to me that if the association goes on record at this time to increase the size of the arch bars it puts its stamp of approval on the arch bar truck. I do not think that is the intention of the association. I, therefore, move that any question of increasing the size of arch bars, as recommended here, be held in abeyance.

Mr. Demarest: I second the motion.

Mr. Goodwin: I would like to ask Mr. Kleine what he has in mind in that motion? Does he have in mind that this arch bar truck is going to be legislated out of existence?

Mr. Kleine: I think the question is properly taken. I do not think it is the intention to legislate the arch bar truck out of existence all at once, but it is the intent and desire to prevent any new cars that may be constructed in the future from using the arch bar type of construction.

Mr. Tatum: Arch bar trucks are in existence in large numbers, and a number of them, it is true, have failed. All of us have experienced these failures. What caused them to fail? Was it the material that the arch bar was made of, or was it the design of the arch bar, or what was the trouble?

To legislate all these arch bar trucks to the scrap pile, in my opinion, would be a willful waste. Further, it is my opinion that it would be wrong to permit repairs to those arch bar trucks when renewals are necessary if we do not set up some means by which to improve them, to continue them in service until the cars they are under are worn out. The recommendation should prevail, and the arch bar truck be continued in service and strengthened as recommended.

Mr. Purcell: The arch bar truck question has been before this body for a great many years. I do not believe there is a railroad but what is having derailments every day due to arch bar trucks giving out. Certainly, the trucks are not being kept up. The column bolts are allowed to get loose. The result is that the entire weight of the car is on the tension members. I have kept a record for 17 months on a little over 12,000 miles of railroad and we averaged 171 broken arch bars per month. It is true, we have had some cast-steel side frames crack, but we have discovered them and taken them out before they broke.

G. Tiley (Gen. Chem. Co.): I have been in charge of 800 tank cars for the last 10 years, which are equipped with arch bar trucks. During that time I have no knowledge of a single derailment or accident from any one of the 800 cars. I make that statement in defense of the arch bar truck as a suitable truck for tank cars, although I am conceding that in the construction of new equipment I should prefer the cast-steel truck side as a result of the experiences of the carriers in the advancement of the design of that particular part.

The motion that the recommendations on arch bars be held in abeyance, was lost.

Mr. Ayers: I would suggest that the car construction committee be requested to modify their recommendation for arch bars to cover simply the renewal of the bar that breaks. The way this reads, if they find an arch bar broken on a truck, the instruction is to renew both of the inverted arch bars on that truck and then if that interferes with the truck, they are allowed to renew the two top arch bars. If that was submitted to letter ballot it would leave the door rather wide open for heavy repairs to any road's cars on foreign lines.

I move that the Car Construction Committee be requested to revise that recommendation to cover the renewals simply of the bar that is found broken on the foreign line. The owner of course has the option of going as far as he likes.

The motion was carried. With the exception of the sections of the report pertaining to Designating Letters for Car Equipment, Hatch Openings for Refrigerator Cars and Design of Journal Wedges, which were submitted to letter ballot, the committee's report was accepted.

Report of Arbitration Committee

T. W. Demarest
Chairman

During the year Cases 1477 to 1532, inclusive, have been decided and copies sent to the members. A copy of these decisions is made part of this report. A vote of concurrence in the decisions is respectfully requested by the committee.

As explained in the 1926 report, there was referred to the committee a recommendation of the Railway Accounting Officers' Association that the Interchange Rules be modified, whereby all charges for repairs amounting to 25 cents and less per car be omitted, and in support of this recommendation it was alleged that the cost of preparing the original record, billing repair card, pricing and rendition of bill and checking thereof, was as great or perhaps greater than the average of charges amounting to 25 cents and less.

The sub-committee appointed to make a study of the situation has completed the investigation and its report is printed as Exhibit A. This report developed that the total average cost of rendering and checking bills for charges amounting to 25 cents and less, based on studies on twelve representative railroads in the United States and Canada, amounted to 7.1 cents per card. The committee, therefore, has recommended the addition of five of the smaller items of repairs to Rule 108, for which no labor or material charge may be made, and which, if adopted, will eliminate approximately 46 percent of the repair cards now being issued for repairs amounting to 25 cents and less. The total labor and material charge for the items so designated is less than or approximately equal to the cost of rendering and checking the bills.

The sub-committee also investigated the practice of writing billing repair cards at the car, which practice has been under trial on several railroads for various periods of time. As this system appears practical and economical, the committee has recommended a modification of Rule 7 to provide for this plan as an optional arrangement.

Attention is again called to the fact that the Arbitration Committee will not consider questions under the Rules of Interchange unless submitted in the form of arbitration cases as per Rule 123.

Freight Car Rules

All recommendations for changes in the Rules of Interchange submitted by members, railroad clubs, private car owners, etc., have been carefully considered by the committee and, where approved, changes have been recommended.

Rule 2

The committee recommends that the second paragraph of Section (c) of this rule be modified as follows:

Proposed Form—Cars equipped with A.R.A. standard axles may be loaded to *limits* shown in Column "A" of Rule 86 (which is the total weight of car and lading for the respective capacities given), *except where stenciled load limit has been reduced, as indicated by star (*) symbol per Rule 30, account structural limitations on car body or trucks.*

Reason—The limits referred to properly apply to all cars equipped with A.R.A. standard axles, except where the load limits have been reduced on account of structural limitations on car body or trucks.

The committee recommends that Paragraph (2) of Section (f) of this rule be modified to read "*metal* transoms."

Reason—To exclue wooden transoms.

Rule 3

The committee recommends that the effective date of the fourth paragraph of Section (a) be extended to January 1,

The committee recommends that the effective date of the sixth paragraph of Section (b) be extended to January 1, 1929.

The committee recommends that the effective date of the third paragraph of Section (c) be extended to January 1, 1929. 1929.

Reason—The present situation justifies these extensions.

The committee recommends that a new fifth paragraph be added to Section (c) of this rule, as follows:

Proposed Form—(5) *Coupler operating levers connected direct with coupler lock or lift without the use of links, clevises, clevis pins or chains, shall be applied to all cars when replacing broken or missing levers where practicable, or when cars receive general repairs.*

Reason—To provide for standardizing of the uncoupling rigging on existing cars, corresponding with the requirements for new cars.

The committee recommends that the effective date of Section (f) be extended to January 1, 1929, as the situation justifies this extension.

The committee recommends that effective August 1, 1927, the third paragraph of Section (s) of this rule be modified, as follows:

Proposed Form—(3) Stenciling: Light weight and capacity in pounds, as provided in Rules 30 and 86, required on all cars. From owners. Tank cars *and live poultry cars* shall be reweighed and remarked by the *owners* or their authorized representatives.

Reason—Account change in Rule 30.

The committee recommends that a new paragraph be added to Section (t) of this rule, as follows:

"Truck side frames with integral journal boxes, conforming to A.R.A. recommended practice, required on all cars built on or after July 1, 1928. From owner."

Reason—As recommended by the General Committee.

The committee recommends that effective August 1, 1927, the second paragraph of Section (t) of this rule be modified, as follows:

Proposed Form—(2) Tank cars (empty or loaded): The dome covers, outlet valve reducers, outlet valve caps, outlet valve cap pipe plugs, heater coil inlet and outlet pipe caps or end plugs and plugs or caps of other openings, must be securely in their proper places; *except empty tank cars used in "Asphalt," "Fuel Oil," or "Lubricating Oil" service, and so stenciled, may be interchanged with steam inlet and outlet caps hanging by their chain or other attachments.*

Reason—To prevent heater pipes from bursting due to condensation freezing, on cars used in service referred to.

The committee recommends that the effective date of the third paragraph of Section (t) be extended to January 1, 1929, and the paragraph modified as follows:

Proposed Form—(3) Tank cars formerly equipped with head block anchorage will not be accepted after January 1, 1929, *unless* tank heads, *if* dented or depressed 1½ *inches or more* due to damage from contact with head blocks, *have been reinforced by steel shoes as required by* Section 5 of Classes I and II Tank Car Specifications. In interchange.

Reason—As recommended by the Committee on Tank Cars. The present situation justifies the extension of effective date.

The committee recommends that the effective date of the fifth paragraph of Section (t) be extended to January 1, 1929.

The committee recommends that the effective date of the second paragraph of Section (u) be extended to January 1, 1930.

Rule 4

The committee emphasizes the importance of notifying inspectors in interchange districts in all cases of defects cardable in interchange where it is impracticable to apply the regular defect card before the car is moved to the interchange district.

Rule 7

The committee recommends that first paragraph of this rule be modified, as follows:

Proposed Form—When repairs are made to a foreign car (except as otherwise provided in Rule 108), or to any car on the authority of a defect card, a form shown on page 254 shall be used for original record of repairs, from which the billing repair card shall be made; *or, in lieu thereof, the original record of repairs may be written directly on the billing repair card at the car, in which event carbon copy of such billing repair card will serve the purpose of original record of repairs as well as record repair card.*

Reason—To make optional the plan of preparing billing repair cards at the car.

Rule 17

The committee recommends that first paragraph of Section (c) of this rule be modified, as follows:

Proposed Form—(c) In replacing couplers, the dimensions of shank and butt *for A.R.A. type D, former A.R.A. standard or temporary standard* couplers, standard to the car, must be maintained, except that 9⅛ in. butt may be substituted for 6½ in. butt when used with A.R.A. standard yoke in substitution for non-A.R.A. standard yoke.

Reason—To clarify the intent.

The commitee recommends that last paragraph and interpretation of Rule 18 be relocated as new last paragraph of Section (c) of this rule, and modified, as follows:

Proposed Form—In replacing former A. R. A. standard couplers, if another make is applied to the car, the uncoupling arrangement shall be made operative at the expense of repairing line; except that coupler operating levers connected direct with coupler lock or lift without the use of links, clevises, clevis pins or chains, may be applied at expense of car owner, when replacing broken or missing levers connected with clevises, links or chains, or when cars receive general repairs; also, when uncoupling arrangement is changed account first application D coupler. The top lift or bottom lift type coupler whichever is standard to the car, shall be maintained.

Reason—To provide for standardizing of the uncoupling rigging on existing cars, corresponding with the requirements for new cars.

The committee has approved the following new interpretations of this rule:

(23) Q—In connection with Section (a), is the substitution of an A.R.A. standard wrought-iron riveted yoke in replacement of a broken cast-steel key yoke considered wrong repairs?

A—Such substitution impairs the strength of the original construction and, therefore, constitutes wrong repairs subject to Rule 88; defect card to be issued for labor only in cases of owner's responsibility.

(24) Q—In connection with the substitution of a wrought-iron yoke for a cast-steel yoke which is not defective, in case riveted yoke coupler is applied on account of a A.R.A. Type D coupler defective, is the repairing line justified in allowing only scrap credit for the cast-steel yoke removed?

A—No.

Reason—Inasmuch as the association has recognized the key design of yoke for new equipment, with no alternative method, it should be protected.

Rule 18

The committee recommends that the last paragraph and interpretation under this rule be eliminated.

Reason—Account of relocating as last paragraph of Section (c) of Rule 17.

Rule 19

The committee recommends that a new item be added to this rule, as follows:

"Plain handle for angle cock."

Reason—The self-locking handle should be made mandatory in repairs as a safety device.

Rule 23

The attention of the committee has been called to the failure of railroads welding cast-steel side frames, to properly anneal them in accordance with the requirements of Rule 23. The present rules permit the welding of side frames in accordance with the regulations contained in Rule 23, regardless of the design of frame, some of which are known to be weak and prone to failure.

It is recommended that the committee on Autogenous and Electric Welding give consideration to the question of prohibiting the welding of side frames.

Rule 30

The committee recommends that a sentence be added to Paragraph (2) of Section (a), that the note under Section (a) and a sentence be added to Section (c) of this rule, effective August 1, 1927, as follows:

Proposed Form—(a) (2) *This requirement does not apply to tank cars or live poultry cars.*

(a) Note*—Tank cars *and live poultry cars* shall be weighed and stenciled by the *owners* only, or by authorized representatives of the *owners*. This paragraph does not apply to tank cars *or live poultry cars.*

Reason—The load limit markings are unnecessary for tank cars and live poultry cars.

The committee recommends that Section (g) of this rule be modified, effective August 1, 1927, as follows:

Proposed Form—(g) When a car is re-weighed and remarked the car owner must be promptly notified of the old and *of* the new *light* weights *and load limits*, with place and date. The proper officer to whom these reports should be made will be designated in The Official Railway Equipment Register.

Reason—To conform to Car Service Rule 11.

The committee recommends that first note following Section (h) of this rule be modified, effective August 1, 1927, as follows:

Proposed Form—Note—All new cars *and* all cars receiving repairs on owner's rails, which require re-light weighing, shall be stenciled with load limit markings, *except* ~~*tank cars and*~~ *live poultry cars.*

Reason—The so-called "rebuilt car" is not recognized in the A. R. A. rules. Load limit markings are unnecessary for tank cars and live poultry cars.

The committee recommends that effective August 1, 1927, the completion date of the second note following Section (h) of this rule be extended to January 1, 1929.

Reason—A time allowance for load limit markings of eight months from the original three year limit is considered ample for the general proposition.

Rule 32

The committee recommends that first paragraph of this rule be modified, as follows:

Proposed Form—Dome covers, discharge valve caps, safety valves or *safety vents* missing from tank cars.

Reason—The safety vents should have the same protection as as safety valves.

The committee recommends that fifth paragraph of this rule be modified, as follows:

Proposed Form—Removing or cutting out parts of car to facilitate loading or unloading, *except in the case of holes bored, drilled or punched in sides, ends or bottoms of gondola cars for the purpose of securing lading in accordance with the Loading Rules.*

Reason—The handling line should not be penalized for such damage when occasioned by compliance with the Loading Rules.

The committee recommends that Section (k) of this rule be modified, as follows:

Proposed Form—(k) Fire damage: *Handling line is responsible for interior as well as exterior fire damage occurring while car is in its possession; otherwise delivering line shall be responsible for only that portion of interior damage as is discernible from an exterior inspection. In the event car is empty the interchange inspection shall be on same basis as though car was loaded insofar as the interior damage is concerned.*

Accordingly, present Interpretations Nos. 1 and 12 of this rule will be eliminated.

Reason—To clarify the intent of the rules as to the responsibility for interior fire damage.

The committee has approved new interpretation of this rule, as follows:

(17) Q.—Arbitration Decision No. 1505 holds the handling line responsible for Rule 44 combination damage where it was the first car struck. Would the responsibility apply to any other cars damaged to the same extent?

A.—If the first, second or third car of either standing or moving cut is damaged to the extent of Rule 44 combination (except as otherwise provided in Section 1 in the case of wood underframe car) the handling line will be responsible.

Reason—It is felt that the responsibility should be on above basis.

Rule 33

The committee recommends that the first paragraph of this rule be modified, as follows:

Proposed Form—Owners will be responsible for the expense of repairs to safety appliances where not involved with other delivering line damage, except *damage to safety appliances* on tank cars when *due to any of the provisions of Rule 32.*

The committee also suggests that Interpretation No. 2 to this rule be modified, as follows:

Proposed Form—(2) Q.—Are repairs to safety appliances chargeable to car owner on car derailed, cornered, sidewiped, or subjected to any other Rule 32 condition where there is no other delivering line damage on the car, it being understood that damage *to safety appliance* on tank cars due to *any of the conditions of Rule 32* is *not* chargeable to owner?

A.—In such cases owners are responsible for the expense of repairs to running boards, handholds, ladders, ladder treads, sill steps, brake shafts, brake step boards, uncoupling levers and parts of these items where not involved with other delivering line damage, except that damage to safety appliances on tank cars *due to any of the conditions of Rule 32* is a responsibility of the handling line.

Reason—The rule now protects tank cars against damage to safety appliances when due to cornering or sideswiping on account of special construction. The same principle should apply to other conditions of Rule 32.

Rule 44

The committee recommends that Section (5) of this rule be modified, as follows:

Proposed Form—(5) Two steel center *sills* on *all-steel underframe* cars having *but* two longitudinal sills.

Reason—To extend protection to other cars similarly constructed.

Rule 49

The committee recommends that Section (c) of this rule be modified, as follows:

Proposed Form—(c) Steel box cars not equipped with cardboards for special explosives and other placards, as required by the I. C. C. Same to be located on side doors and both ends of car. Size to be not less than 16 by 24 in.

Reason—To conform to A. R. A. recommended practice.

Rule 57

The committee recommends that cut shown on Page 93 for airbrake hose label be revised to show the A. R. A. monogram in horizontal position instead of vertical.

Reason—To conform to A. R. A. standard design.

Rule 60

The committee recommends that, effective August 1, 1927, Interpretation No. 1 of this rule be eliminated on account of being covered in Interpretation No. 4; also, that the present Interpretation No. 4 be relocated as new Interpretation No. 1 and last old paragraph of the answer be eliminated.

Reason—Account of being covered in the revised Interpretation No. 2. The committee also recommends that effective August 1, 1927, Interpretation No. 2, to this rule be modified, as follows:

Proposed Form—(2) Q.—In case air brakes are cleaned within nine months from date of last previous cleaning, may owner be billed for the work?

A.—*Yes, in the event of air brakes being inoperative, except as follows:*

If *the* brakes are cleaned *by* same road within sixty days from date of *the previous* cleaning, charge for *such* subsequent cleaning is not permissible, regardless of whether the previous cleaning was charged.

If the brakes are cleaned on different roads or private car lines within sixty days from date of previous cleaning, the entire charge for such previous cleaning shall be withdrawn, except where the last cleaning was occasioned by delivering line defects. Where the last cleaning is done by car owner, joint evidence, per Rule 12 shall be used to establish the defective condition which occasioned such cleaning. These provisions apply when the subsequent cleaning was done on or after August 1, 1927.

Reason—A road performing this work should be responsible for it for a period of sixty days.

Rule 66

The committee recommends that the effective date which makes owners responsible for periodical repacking of journal boxes be extended to May 1, 1928.

Reason—As authorized by the general committee and announced in Circular D. V.-505, issued April 18, 1927.

Rule 86

The committee recommends that the effective date of the

third paragraph of Section (b) of this rule be extended to January 1, 1929.

Reason—The present situation justifies this extension.

The committee recommends that second paragraph of Section (f) of this rule be modified, as follows:

Proposed Form—See Rule 2, paragraph (c). Cars equipped with A. R. A. Standard axles may be loaded to *limits* shown in Column "A" (which is the total weight of car and lading for the respective capacities given), *except where stenciled load limit has been reduced, as indicated by star (*) symbol per Rule 30, account structural limitations on car body or trucks.*

Reason—To conform to the change in Rule 2, Section (c).

Rule 98

The committee recommends that paragraphs two and four of Section (b) of this rule be modified, and that paragraph six of Section (b) be made new paragraphs six and seven and modified, as follows:

Proposed Form—2. In the case of cut journal, where one or both wheels are condemned account owner's defect, if new axle and new wheels are applied, charge against car owner shall be confined to net value of the new wheels, except as otherwise provided in Rule 86, Section (b), second paragraph. In such case if *one wheel is condemned account owner's defect and* mate wheel is condemned by remount gage, per Rule 82, renewal of *both wheels* shall be made at expense of *car owner*.

4. If repairs are made by other than car owner on authority of defect card bill on such defect card shall be on basis of material actually applied and removed, except insofar as owner's defects are otherwise provided for in paragraphs 2, 3, 6 *and* 7.

6. Where car owner removes a scrap axle on authority of defect card, charge shall be confined to difference in value between the new or second-hand axle applied and scrap axle removed, including wheel condemned by remount gage, per Rule 82, *except where mate wheel is condemned account owner's defect, in which case the owner shall assume the expense of renewal of both wheels.* Rule 65 also applies.

Proposed Form—7. Where car owner removes a scrap wheel on authority of defect card, charge shall be confined to difference in value between the new or second-hand wheel applied and scrap wheel removed, including mate wheel condemned by remount gage, per Rule 82, or axle condemned by remount limit per Section (c) of Rule 86. Rule 65 also applies.

Reason—The car owner should reasonably assume the expense of renewing both wheels when one of them is renewed on account of owner's defect and the mate wheel on account of the remount gage.

The committee has approved the following new interpretation:

(10) Q.—Where wheels are applied to a foreign car (regardless of responsibility) and subsequently removed within a short period of time on account of the conditions of wear, has the car owner any redress from the road making previous application?

A.—If the same pair of wheels is removed on any road or private car line within sixty days from the date of previous application, due to worn through the chill, worn flange or tread worn hollow, the initial charge (for the wheels, axle, brasses, etc., and labor) shall be withdrawn in case of owner's responsibility for such previous application; in case no bill was made against the car owner for the previous application, the car owner may render a counterbill against the road which made the previous application, for the expense of the subsequent application.

Reason—It is considered that second-hand wheels should give at least sixty days service insofar as such conditions of wear are concerned.

Rule 104

The committee recommends that the first two paragraphs of this rule be modified, as follows:

Proposed Form—Secondhand A. R. A. *type D* couplers or parts *of same* shall be charged and credited at 75 per cent of value new. Credit shall be allowed for all parts of such couplers.

Second-hand former standard or temporary standard couplers or parts of same shall be charged and credited at 50 per cent of value new. Credit shall be confined to the body, lock, knuckle and knuckle pin.

When new coupler is applied it shall be so charged whether or not it is of same make as that removed.

The committee also recommends that Items 132 and 133 of Rule 101 be revised to exclude reference to second-hand bodies.

Reason—The growing obsolescence of the former standards and parts justifies reduced prices and credits for them.

Rule 108

The committee recommends the addition of the following items to this rule, for which no labor charge may be made:

Sill step braces or supports (tightened or straightened on car).

Ladders and ladder supports (tightened or straightened on car).

Adjusting lock details of couplers.

Reason—It is desirable to include these items.

The committee also recommends the addition of the following items to this rule, for which no labor or material charge may be made:

Air hose gaskets, except as included in charge for complete hose applied.

Brake shoe keys, under all conditions.

Release valve rod and cotter, under all conditions.

Spring cotters or split keys, under all conditions.

Wood screws (other than lag screws), except where six or more are applied.

Reason—To eliminate preparation of car repair records and bills where the charge for the item does not justify such expense.

Rule 120

The committee recommends that the repair limits for labor and under Section (b) of this rule be reduced approximately 33 per cent and exclude truck repairs.

Ten-Wheeled Type Locomotive Presented by the Missouri Pacific to the Agricultural and Mechanical College of Texas for Experimental Service in the Steam Laboratory—Elaborate Exercises Accompanied the Presentation Made December 11, 1926

Reason—In order to further restrict extensive repairs to cars without authority of owner.

Passenger Car Rules of Interchange

RULES 7 AND 15

The committee recommends that Section (a) of Passenger Rule 15 be relocated as new Section (j) of Passenger Rule 7 and modified, as follows:

Proposed Form—Rule 7. (j) Brakes must be in working order. Brake cylinders, slack adjusters, triple valves, control valves and high speed reducing valves *not* cleaned, oiled and tested within *the last* twelve months, *as shown by the Standard Markings.* The place, month, day and year of last cleaning and oiling and the initials or name of road *to be* stenciled with white paint in a suitable location for visual inspection. Dirt collectors and strainers must be cleaned at time of cleaning triple valves or control valves.

Reason—To clarify the intent and relocate the rule in the proper place.

RULE 8

The committee recommends that Item 4 of Section (a) of Passenger Rule 8 be modified, as follows:

Proposed Form—(4) Impact *in switching, except damage to couplers and attachments, buffers and diaphragm face plates or parts thereof.*

Reason—To definitely indicate the responsibility of the handling line for cars handled in switching.

The report is signed by T. W. Demarest (chairman), Penna.; J. E. O'Brien (vice-chairman), Seaboard Air Line; F. W. Brazier, N. Y. C.; J. J. Hennessey, C. M. & St. P.; J. Coleman, Canadian National; H. L. Shipman, A. T. & S. F.; G. F. Laughlin, Armour Car Lines, and Thos. Beaghen, Jr., Mexican Petroleum Corporation

The report was accepted.

Report on Prices for Labor and Materials

A. E. Calkins
Chairman

In order that the rules may currently provide an equitable basis for inter-road billing, the committee has continued the work of analyzing material, labor and new equipment costs with a view of determining and recommending necessary changes to be made effective August 1, 1927.

All miscellaneous material prices in Rule 101 were rechecked as of March 1, quotations from purchasing agents of eleven large roads, representing 39 per cent of the total freight car ownership in the United States and Canada, indicating that no changes were necessary in new or scrap prices except in the case of brake shoes and steel castings. Downward recommendations are made in these instances.

Air brake material prices remain practically unchanged with the exception of several covering cylinders, which are recommended for adjustment in order to cover parts bearing new piece numbers.

Attention is called to recommended changes in the phrasing of air brake material charges in Rule 101, Items 57-D, 57-E, 57-F, 57-G, 57-H, 57-L, 57-N, 57-P and 57-Q, to clarify the limitations under which the $30.40 or $22.13 net charges may be made for replacement of nonconvertible with K-1, K-2 or convertible triple valves.

A complete table of friction draft gears is being submitted for approval with the view of incorporating information as to the length of gear and pocket for which intended. This is to facilitate checking of repair bills. There are only six instances where the indicated prices for gears reflect changes over those shown in current rules.

Based on data received from nine large representative roads in March, 1927, as to daywork hourly rates paid all employees directly engaged in freight train car repairs, the weighted average hourly rate was found to be $0.6562. Adding the 61.92 per cent overhead heretofore authorized, produced $1.0625 and your committee is recommending the adoption of a labor rate per hour for freight car repairs of $1.05 effective August 1, 1927, in lieu of the existing rate of $1.00.

Item 172 of Rule 101 and Item 442 of Rule 107 are therefore shown at $1.05 in appended report.

The committee recommends that the $1.15 hourly rate covering the repairs of steel tanks of tank cars, as shown in Item 443 of Rule 107, be increased to $1.20.

The truck combination labor charges, incorporated in Rule 107 on January 1, 1927, have doubtless proved satisfactory to billing clerks and have reduced correspondence.

The 0.1 hr. labor allowance in Item 237, Rule 107, covering nuts or nut locks, has been reduced to $0.07.

New Item 243 is also recommended to cover the painting and stenciling of cars or parts not repaired or renewed, when performed on authority of defect card.

Other miscellaneous changes are recommended in time allowances under Rule 107 where clarification or reduction was justified.

No changes are suggested at this time in the detailed labor allowances of air brake Rule 111 as the result of the recommended 5 per cent change in hourly rate.

Recommendations are made in Rule 112 respecting reproduction pound prices of new freight train cars of all classes in order that supplement of August 1, 1927, may reflect 1926 costs in lieu of 1925 figures shown in the present code. The prices submitted for your approval will be found to follow the trend which occurred in the 1926 market covering total new equipment purchases as compared to 1925. Pound prices for refrigerator, poultry and tank cars are based on figures furnished by representative roads and private lines in the United States and Canada. Prices for all other equipment represent the average selling prices set up by the Presidents' Conference Committee, which secured quotations on the total output of several large United States car manufacturers. Figures from Canadian roads for other than refrigerator cars were not used as their total ownership is less than one-tenth that of the United States carriers and the effect of including it in the weighted average would be negligible.

A slight change is made in phrasing of the rule covering depreciation rates to bring out the fact that the 3 per cent and 5 per cent rates apply to the entire care of those tank cars intended for non-corrosive and corrosive commodities, respectively.

Data submitted by nine large roads indicate that the average hourly rate paid employees engaged in passenger train car repairs in March, 1927, was $0.7072, which, with the addition of 61.92 per cent overhead, produced $1.145. The committee is, therefore, requesting your approval of a labor rate per hour for passenger car repairs of $1.15, in lieu of the $1.10 now authorized in Item 20 of Passenger Car Rule 21, and also an hourly labor rate for lubrication of $0.82, in lieu of the $0.78 now shown in Item 19 of the same rule.

It is the intent of the committee to investigate labor and material costs again in October, and if sufficient change develops necessary revision will be made and inserted in the Rules effective January 1, 1928.

The report is signed by A. E. Calkins (chairman), New York Central; Ira Everett, Lehigh Valley; J. K. Watson, A. T. & S. F.; E. H. Weigman, K. C. S.; T. J. Boring, Penn.; H. H. Harvey, C. B. & Q.; H. H. Boyd, Canadian Pacific, and A. E. Smith, Union Tank Car Company.

The report was accepted.

C. P. R. Terminal at St. John, N. B.

Report of Committee on Tank Cars

A. G. Trumbull
Chairman

The activities of the Tank Car Committee during the past year have been influenced by the adoption of specifications for tanks by the Interstate Commerce Commission and by developments in the petroleum and chemical industries affecting not only certain important details of existing tank car construction, but involving as well radical departures in design.

As was forecast in the discussion of the committee's report to the association in 1926, the Interstate Commerce Commission in its Docket No. 3666 proposed modifications in the general regulations covering the transportation of explosives and other dangerous articles by freight, under the provisions of which specifications are incorporated covering shipping containers described as "riveted and welded metal and wooden tanks to be mounted on or to form part of a car."

A hearing was held before the Commission on October 27, 1926, which was attended by the chairman of the Tank Car Committee as well as representatives of various interests concerned in the specifications proposed to be adopted.

Following the hearing, the Commission, by formal order dated January 22, 1927, has promulgated amendments to the regulations mentioned whereunder, after July 1, 1927, all tanks must be built which are used for the transportation of inflammable or dangerous articles by freight.

The specifications, in general, follow the provisions of the American Railway Association for tanks effective on March 1, 1926, and as amended by letter ballot of the Association in respect of certain recommendations of the committee incorporated in the 1926 report.

The action of the Commission in adopting these specifications makes necessary a revision of the existing specifications of the American Railway Association in respect of tanks used for the transportation of commodities included in the Commission's regulations for the transportation of explosives and other dangerous articles by freight, but, as to all other articles which may be transported in tank cars and which are not classed as dangerous in the regulations mentioned, transportation may be made only in such tanks as meet the requirements of the Association's specifications either existing or to be adopted.

On due consideration of the subject, the Tank Car Committee has concluded that it will be necessary to continue the publication of the existing specifications because of the fact that so large a number of tanks are now in service which have been built in compliance therewith and with respect to which questions are likely to arise for many years to come. It was concluded, however, that the specifications should be revised in respect of tank cars which may be built after July 1, 1927, and which will be equipped with tanks complying with the Interstate Commerce Commission specifications. In connection with the revision of these specifications which will be undertaken by a sub-committee consisting of Messrs. Lindner and Cooper and the chairman of the committee there will be included specifications for tanks not heretofore included in those issued by the association.

Multiple Unit Cars

Interest in cars of this description is being stimulated by requirements for the transportation of chemicals, particularly chlorine. The committee, in collaboration with the Car Construction Committee, now has under consideration a car of this description.

Top Loading and Unloading Devices

Owing to the losses which occur through evaporation in handling highly volatile liquids in tank cars equipped with the type of dome closure in general use, there has been increased interest in measures calculated to avoid such losses. The Skelly Oil Company has been particularly active in this field and has contracted for the construction of a number of cars designed for top loading and unloading without opening the dome closure. This is effected by the installation of pipes extending to the bottom of the tank from a recess fitting enclosed in the dome opening. The upper portions of the pipes are provided with suitable valves and with means to permit the attachment of loading and unloading pipes. Under ordinary service conditions, the exposed portions of the pipes and valves are protected by a substantial cover securely fastened in place.

Tank with Lock Bar Joints

In the committee's report of 1926, reference is made to a tank with so-called lock bar joints. This tank has since been completed and mounted and is now in service under appropriate restrictions governing experimental construction.

New Specifications

The Class V tank now covered by the specifications was designed for the transportation of inflammable liquids having a vapor pressure not exceeding 20 lb. per sq. in. at a temperature of 100 deg. F. The Class V car was designed for the shipment of compressed liquefied gases having a vapor pressure not exceeding 130 lb. per sq. in. at 70 deg. F. In order to supply the gap between the limits prescribed by these specifications, Class IV-A specifications were drawn. Up to date, however, only 10 cars of this class have been built, all of which were intended for the transportation of ethyl chloride. Owing to developments in the petroleum industry and to the fact that there appears to be no need for additional Class IV-A cars of the original design, the continuation of the original specification no longer appears to be necessary.

Request has been made for approval by the committee of a car to be used for the transportation of liquefied petroleum gases having a vapor pressure of not more than 33 lb. per sq. in. at 70 deg. F. and there are indications that the demand for such a car will increase and since its cost will be substantially less than that of the Class V car, your committee proposes a revision of the Class IV-A specifications to satisfy this demand. The proposed specifications which will be recommended to the Interstate Commerce Commission for incorporation in the regulations for the transportation of explosives and other dangerous articles by freight will be known as shipping container Specification 104-A Revised, and are presented herewith as Appendix A of this report. This specification is offered for approval by letter ballot.

Revisions in the Existing Specifications

Service—Class I Cars—On recommendations of the Tank Car Committee, there was submitted to the association in 1926 a proposed amendment to the specifications prohibiting the transportation of inflammable or corrosive products in Class I cars after January 1, 1928. Subsequently, evidence was presented to the committee in substantiation of the statement that this prohibition would affect a considerable number of cars used for the transportation of acid which are rendering satisfactory service and which appear to be suitable for continued use. Under these circumstances, it is recommended that the limitation of the use of the Class I cars be restricted only to those used in the transportation of inflammable products.

Section 7—Bottom Outlets—Figure 2 on page 80 of the specifications has been the cause of much confusion on the part of builders of tank cars and as the purpose of this sketch is chiefly to illustrate the outlet, it is proposed that the diagram be revised to cover this feature only, eliminating all the other details including the illustration of the dome, the contained parts thereof and the valve.

Section 20—Safety Valves—The revision in the certificate of construction has been the means of directing the attention of the committee to certain desirable changes in the details of the standard 5 in. safety valve, Fig. 9-A, which it is proposed to amend in the following particulars:

(a) Omit the finish mark on the surface of the huddling chamber outside of the valve seat.

(b) Omit the finish mark in the bore of the spring follower requiring $\frac{11}{16}$-in. cored hole only.

(c) Require that the valve stem be finished on the 45-deg. face.

(d) Fig. 10-A. Remove the finish mark from that portion of the huddling chamber outside of the valve seat.

(e) Omit the finish mark on that portion of the spring case below the thread and also on the inside below the valve.

(f) Omit the finish mark from the bottom of safety valve collar or flange.

Section 24—Tests of Safety Valves—Omit paragraph two relating to tests without removal of the valve from the car as this is no longer permissible and also eliminate Fig. 13 showing the apparatus for testing safety valves in place on cars.

Tank Heads

Numerous reports have reached the committee of damage occurring to tanks through failure of the heads. Inquiry develops that much study has been given the subject of proper radius of the throat of the tank head flange. A question was also raised regarding the present provisions of the specifications requiring

that tank heads shall be dished to a radius of 10 ft. on the concave side.

The committee considers the subject of sufficient importance to warrant a careful investigation of the researches which have been made and consideration of a revision of the existing specification requirements in order to provide for improved design and construction. A subcommittee has been appointed for this purpose.

Safety Valves, Dome Covers and Bottom Outlet Valves

In accordance with the report rendered to the association in 1925, the joint committee of the American Railway Association, American Petroleum Institute and the American Railway Car Institute has organized and named A. E. Smith chairman. The joint committee has done considerable work in connection with the subject of bottom outlets, dome covers and safety valves and has been fortunate in securing for the purpose of this investigation the services of D. V. Stroop of the United States Bureau of Standards. Through this arrangement, sources of information will be open to the committee which would not otherwise be available.

Mr. Stroop has entered upon his duties and a series of tests of various devices will shortly be conducted under the auspices of the joint committee and the immediate direction of Mr. Stroop. It is hoped that all those that are interested in the promotion of the safe transportation of inflammable and dangerous liquids and the solution of the transportation problems incident thereto will submit their devices for the prescribed tests.

Report of Subcommittee on Bottom Discharge Outlets

Subcommittee on Bottom Discharge Outlets, since its report of May 6, 1926, has received for consideration four new designs of bottom discharge outlets and three revisions of designs of bottom discharge outlets which had been submitted to the subcommittee prior to that date.

Of the four new designs, only one, that submited by the Midwest Railway Equipment Company, was approved for service trial. It has not as yet been applied to any cars. Of the three revised designs, one was not approved, the other two were approved and are now undergoing service trial. Of these two, the Carr valve, submitted by the Pure Oil Company, should be added to the summary of valves which comply with the specifications effective March 1, 1926, submitted with our 1926 report. The other submitted by the Panhandle Refining Company was previously included in this summary.

Reports covering the performance of valves which have been applied to tank cars and are operating under actual service conditions have not developed any information which would cause the sub-committee to change its previous views in regard to the desirability of requiring the use of valves which are positively held on their seats by some means other than a spring.

It is anticipated that a comparative test of the different designs of bottom discharge outlets now in service, which test is shortly to be made by a joint committee composed of representatives of the American Railway Association, the American Petroleum Institute, and the American Railway Car Institute, under the direction of an associate engineer of the U. S. Bureau of Standards, will enable the Tank Car Committee to recommend to the Interstate Commerce Commission at least several of these designs for inclusion in the Commission's specifications as recognized standard designs of bottom discharge outlets, providing, of course, for the addition to this list from time to time of such designs as similar comparative tests indicate are equally satisfactory.

The report of the subcommittee on Bottom Discharge Outlets is signed by W. E. Cooper (chairman), J. T. St. Clair, and Thomas Beaghen, Jr.

Minority Report

A minority report was submitted by A. E. Smith in which he expressed the opinion that paragraph 3 of the sub-committee's report is misleading as the committee is not receiving current reports on the operation of all valves of the type referred to and, therefore, would not be advised of any troubles which might be experienced as shown on previous reports rendered to the committee.

Report of Subcommittee on Dome Covers and Safety Valves

Safety Valves

Your committee in its 1926 report submitted details of the test of a safety valve manufactured by the American Car and Foundry Company. Valves of this type were applied to tank cars of several companies and were to be continued in service for a period of one year and then retested to determine their condition.

Valves as applied by the Union Tank Car Company, Mexican Petroleum Corporation and Texas Company were allowed to remain in service for a period of one year and are now being held awaiting test by the joint committee to be conducted under the direction of D. V. Stroop, at the Philadelphia shops of the Union Tank Car Company. The Union Tank Car Company is also holding six standard A.R.A. valves which were applied new at the same time as the above noted valves, and comparative test is to be made of these valves with those built by the A. C. and F. Co. The valves applied by the Mid-Continent Petroleum Company were removed and we have a report of the yearly test from Mr. Parsons, master car builder, part substantially as follows:

All of the valves were removed and placed over test rack and found to be in perfect condition. Five opened at 27 lb. and closed at 25 lb. One opened at 25 lb. and closed at 24 lb. The water test made for leakage showed the first bubble at from 9 to 18 lb., and boiled at from 20 to 24 lb.

Dome Covers

In our 1926 report the sub-committee reported on nine types of dome covers and unloading devices undergoing service trial. A general description of the various types was included in the report.

No. 1—Skelly Oil Company—Special loading device.—The results obtained from this and the questionnaires are being followed by W. E. Cooper, Bureau of Explosives.

No. 2—Holmes Universal Gas-tight Dome Cover.—None of this type has been applied.

No. 3—Shanley loading and unloading device.—Approval has been given for trial application to not more than five cars. We have no advice that they have ever been applied.

No. 4—The Humble loading and unloading device submitted by Humble Oil and Refining Company.—This device was applied to five cars. Information obtained from questionnaires submitted to the sub-committee indicated a favorable performance. No evidence of pressures leaking through the covers and no difficulties experienced in maintaining tight joints or difficulties experienced in unloading; nor were there any repairs necessary due to failure of any parts. The application to 50 additional cars was approved by the subcommittee, September 28, 1926.

No. 5—Dome cover and ring by the American Car and Foundry Co., equipped with safety device.—No information of value was obtained and no further information during the past year has been obtained, and no request for additional applications of this cover have been made.

No. 6—Safety dome cover by the General American Tank Car Corporation.—It is indicated in our 1926 report that this cover had been applied to 225 cars built for the Phillips Petroleum Company, and on information obtained from questionnaires submitted by them, the cover is evidently giving satisfactory service, with the exception of one report received that some of the cars loaded with casinghead gasoline, with internal pressure apparent, the cover could be removed while pressure existed in the tank.

No. 7—American Car and Foundry Company hinge type dome cover which opens downward into the dome.—Reports received on this type of cover indicate that further investigation is necessary in connection with the suitability of this cover for cars used in the transportation of casing head gasoline.

No. 8—American Car and Foundry Company hinge type pressure locking dome cover.—We have no advice that authority had ever been granted by the Interstate Commerce Commission for a trial application of this type cover.

No. 9—Closed circuit loading device—Union Tank Car Company.—Authority has been granted for its application to 250 U. T. C. cars. To date we have advice of test application to 122 cars and the results obtained from the service trial are being followed by W. C. Cooper, Bureau of Explosives.

We also have been following the performance of the American Car and Foundry Company self venting pressure locking dome cover screw type. This is an A. R. A. screw type dome cover with internal lift actuated by pressure within the tank which is intended to prevent its removal while pressure exists. While we have ten of these covers in service, no reports have been received which permit an expression of opinion as to the possibilities of this cover for use in casing head gasoline service.

No complaints have been received covering the performance of the A. R. A. fundamental bolted type dome cover which has been applied to a large number of Class III tank cars, and your committee expects shortly to recommend standard type of dome cover for the Class IV cars.

The report of the subcommittee on Dome Covers and Safety Valves is signed by W. C. Lindner, chairman; I. T. St. Clair, Geo. McCormick and A. E. Smith.

Appendix A—Proposed Revision of Specification No. 104A

1. *Type*—Tanks built under this specification must be cylindrical in form with heads dished convex outward. The tank must be provided with a manhole ring and cover on top of the tank of sufficient diameter to permit access to the interior of the tank and to provide for the proper mounting of inlet, outlet, and safety valves, and a protective housing on the cover. No other opening in the tank is permitted.

The tank, except where it is seated on the bolsters of the car, must be lagged with compressed cork board properly molded to fit, or other material of equivalent heat insulating and shock resisting quality, to a thickness of not less than 4 in. When heater pipes are attached to the exterior of the tank, the thickness of the lagging over each pipe may be reduced to not less than 2 in. A jacket of sheet metal not less than one-eighth inch in thickness, welded or otherwise fastened together, must entirely cover the lagging. Openings through the lagging must be flashed around projections to prevent admission of water. The manhole ring must be so constructed that liquid cannot enter between its wall and the jacket. The tank must be well painted before being lagged and the inside of jacket must be painted before it is applied.

2. *Bursting Pressure*—No change, except that the calculated bursting pressure must be not less than 495 lb. per sq. in.

3. *Material*—All plates for tank must be made of open-hearth boiler-plate steel of flange quality. All external projections must be made of materials specified hereinafter. Rivets must be of the same quality as used for steam boilers and other pressure vessels.

4. *Thickness of Plates*—The minimum thickness of plates, including thickness of each plate at rivet seams, must be as follows:

Diameter of tanks	Bottom sheets	Shell sheets	Tank heads
87 in. or under	9/16-in.	9/16-in.	11/16-in.
Over 87 to 96 in.	5/8-in.	5/8-in.	7/8-in.

5, 6 and 7. No change.

8. *Calking*—All seams must be calked both inside and outside, except that outside calking of seam formed by attachment of manhole ring is not required.

9. *Expansion Dome*—No expansion dome is permitted.

10. *Closure for Manhole*—All joints between manhole cover and manhole ring, and between manhole cover and valves mounted thereon, must be made tight against vapor pressure, and to secure this a suitable gasket must be used, except where safety valve screws into manhole cover.

11. *Manhole Ring and Cover*—The manhole ring must be constructed of cast or pressed steel, having a wall thickness not less than the thickness of the wall of the tank, with a cover of steel plate not less than 2 in. thick, on which is bolted a valve-protecting housing of cast or pressed steel fitted with a steel cover that can be securely closed. The cover must be provided with screened openings over the safety valve. The housing may be provided with openings to permit the connecting of piping with the venting and discharge valves without removal of the housing. The manhole cover must be attached to the manhole ring by through bolts or studs not entering the tank.

12. *Venting and Discharge Valves*—(a) The venting and discharge valves must be of the flange type, made of material not subject to destruction, by the lading, and must withstand a pressure of 300 lb. per sq. in. without leakage. The valves must be directly bolted to seatings on the manhole cover. Provision must be made for closing the pipe connections of the valves.

(b) The eduction pipes of the discharge valves may be equipped with ball check valves.

13. *Bottom Discharge Outlets.*—No bottom discharge outlet is permitted.

14. *Safety Valve*—(a) The tank must be equipped with one 5-in. safety valve mounted on manhole cover. Valve must have a discharge capacity sufficient to prevent building up of pressure in the tank in excess of 100 lb. per sq. in. should the tank be exposed to fire.

(b) The safety valve must be set to open at a pressure of 60 lb. per sq. in. (For tolerance see paragraph 18 on tests.)

15. *Fixtures and Other Attachments*—No attachments other than those mounted on the manhole ring and cover, the anchorage, and safety appliances are permitted, except that heater pipes may be attached directly to the exterior of the tank by suitable bands. Safety appliances should preferably be attached to pads on the jacket or to suitable tank bands.

16. *Plugs for Openings*—Not required.

17. *Tests of Tanks*—Each tank must be tested before being put in service and also at intervals as prescribed in paragraph 19, by completely filling the tank and manhole ring with water, or other liquid having a similar viscosity, of a temperature which must not exceed 100 deg. Fahr. during the test, and applying a minimum pressure of 100 lb. per sq. in. The tank must hold the prescribed pressure for not less than 20 min. without leak or evidence of distress. All rivets, valves, except safety valves, and connections entering the tank must be in place while this test is made. If the jacket and lagging are not removed, a drop in pressure shall be evidence of leakage, and such portion of the jacket and lagging must be removed as may be necessary to locate the leak and make repairs. After the repairs have been made, the tank must again be subjected to the prescribed test.

18. *Tests of Safety Valves*—No change, except that valve must not leak below 55 lb. pressure. The valve must open at the pressure prescribed in paragraph 14(b), with a tolerance of plus or minus 5 lb.

19. *Retests of Tanks and Safety Valves*—No change, except that tanks and valves must be retested at intervals of not more than two years after the original test.

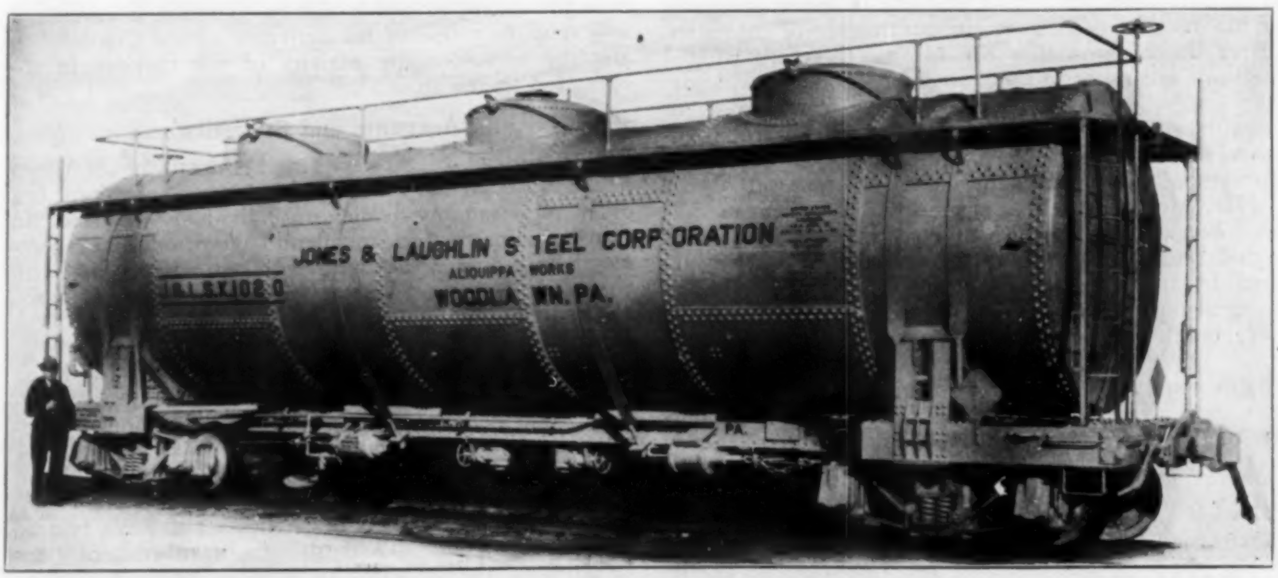
20. *Marking*—Each tank must be marked as follows:

(a) to (d) inclusive. No change, except that the marking must be I. C. C.-104A and the stenciled marks must be on the jacket.

(e) Water capacity of the tank in pounds stamped plainly and permanently in letters and figures not less than 3/8 in. high into the metal of the tank immediately below the mark specified in paragraph 20(b). This mark must also be stenciled on both sides of the valve protecting housing in letters and figures at least 2 in. high.

21. *Reports*—No change.

The report of the full committee was signed by A. G. Trumbull (chairman), Erie; J. T. St. Clair, Atchison, Topeka and



Tank Car Built by the Standard Tank Car Company, Sharon, Pa., for the Jones & Laughlin Steel Corporation for the Transportation of Hot Tar—Capacity 20,000 gal.; Light Weight, 88,000 lb.

Santa Fe; G. McCormick, Southern Pacific; W. C. Lindner, Penna.; B. W. Dunn, Bureau of Explosives; A. E. Smith, Union Tank Car Company; T. Beaghen, Jr., Mexican Petroleum Company; H. L. Worman, St. Louis-San Francisco; G. E. Tiley, General Chemical Company and C. C. Meadows. Tidal Refining Company.

Discussion

In presenting the report Mr. Trumbull made the following remarks:

Subsequent to the printing of the report, the committee's attention was invited to the fact that there is a descrepancy in he provisions for the present specifications of Class I, II and III cars, and those of the Interstate Commerce Commission, with respect to the period within which the safety valves are required to be tested.

If there is no objection voiced here, the requirement will be that tanks and safety valves must be retested within 10 years after the original test. The present provisions of the specifications for Class I, II and III cars are that the retest shall be every two years.

The report was accepted.

Co-operative Railroad Regulation

By Frank McManamy
Member, Interstate Commerce Commission

Photo Clinedinst

F. McManamy

The present magnificent transportation facilities are simply the inevitable result of the application of the brain and energy of an aggressive people to the problem of developing a vast continent. To those concerned with the present performance and the future policy of railroad transportation, the record of the past century of progress possesses more than mere historic value. There are lessons to be learned from past performances. This is true not only with respect to the physical design and operation of equipment and facilities, but it is equally true with regard to the broad questions pertaining to management and the relations of the railroads to the public.

What are the principal events that led up to and the influences which brought about the methods of operation and regulation of railroads which exist today, and are they co-ordinated so that they can function in the way that will to the greatest possible extent protect and promote the interests of the public which, after all, is the only legitimate reason for their existence? The answer to the latter question cannot properly be given by you or by me, because each of us, in our respective capacities, shares the responsibility for results, therefore what I shall say will relate to the former question and will partake somewhat of the nature of a progress report or description of methods to aid those whom we are all endeavoring to serve in reaching an intelligent conclusion with respect to the latter question.

(Mr. McManamy here explained that American railway development can be divided into three distinct periods: namely, that in which expansion was encouraged by the government; that in which questionable financial methods and rebating, with its attendant evils, were indulged in; and the present or third period, in which government regulation, made inevitable by conditions common in the second period, is in force. He then gave a brief resumé of the organization and activities of the Interstate Commerce Commission, which was created by an Act of Congress approved February 4, 1887.)

I wish now to touch upon the method adopted by the Commission to bring about harmonious co-operation between shippers, carriers, and the Commission, as the representative of the public, so that the laws may be administered without unnecessary formal proceedings, either in the courts or before the Commission, without friction and at a minimum of expense.

In its third annual report, dated November 30, 1889, referring to the method of administering the law, the Commission said:

> In consideration of the motives that usually influence human conduct in great business affairs in which the whole country is concerned, it was believed that at the outset at least, and until leading principles were fairly settled, it would be more profitable for the Commission for the most part to lay down rules of conduct for the present and future, and by frequent conference and intercourse with managers to have those rules observed, than to devote its time mainly to instituting and conducting penal and criminal prosecutions. * * *
>
> It is not intended to be implied that official prosecutions should not be instituted directly by the Commission. The enforcement of the law by the methods provided for in the act is a part and a material part, of its duty, and prosecutions constitute one of those methods. It is only meant that prosecutions in the courts, inaugurated and carried on by the Commission, would necessarily have superseded other duties that were more useful and apparently more important.

In every way consistent with proper administration of the law, the policy above outlined has been not only continued but developed by the Commission until at present co-operation between all parties at interest to bring about a proper observance of the requirements of the laws has developed to a point which at that early day was not possible. In fact, the increase in the scope of the Commission's work since that declaration of policy was made has been such that without co-operation developed to its fullest extent the work assigned to the Commission by law would be impossible of accomplishment. To illustrate the extent to which this co-operation is carried, I will refer to a few of the activities of the Commission and the corresponding activity of the carriers in co-operation therewith.

Accounts and Statistics

Our Bureau of Accounts and Bureau of Statistics have always invited not only carriers' organizations, but other representative bodies or individuals interested in transportation matters, to submit suggestions and recommendations tending to improve or better harmonize with the public needs the Commission's accounting and statistical regulations.

In connection with the revision of steam road classifications now in progress, close contact is also being maintained by these bureaus with the committee on accounts and statistics of the National Association of Railway and Utilities Commissioners.

Such organizations as the United States Chamber of Commerce, National Industrial Traffic League, chambers of commerce of different cities which have evinced interest in the classifications, members of the faculties of the principal universities, various publications specializing on transportation matters, and prominent public accounting firms have been invited to submit

their views and comment as to the tentative classifications for steam roads recently drafted.

Other organizations, such as the National Council of Traveling Salesmen, have made application to the Commission for an opportunity to express their views as to what the accounting classifications should provide. They will be afforded full opportunity to do so.

It has consistently been the Commission's policy to develop through the Bureau of Accounts and the Bureau of Statistics the fullest information as to all proposed changes in accounting and statistical requirements. Constructive criticism is invited and is always welcomed from whatever source.

Responsive to this, the principal classes of carriers subject to the interstate commerce act have created organizations composed of the chief accounting officers of the respective companies such as the Railway Accounting Officers' Association, the Association of Water Line Accounting Officers, or similar organizations, for the very purpose of co-operating with the Commission through its several bureaus in improving accounting methods, standardizing forms, and generally promoting efficiency in accounting. These organizations, through their appropriate committees, confer with representatives of our Bureau of Accounts and Bureau of Statistics as to the disposition of important accounting questions that are constantly arising, and particularly in connection with the adoption of new accounting rules or statistical regulations. The co-operation of the carriers' accounting organizations is especially helpful in connection with the revision of the accounting classifications undertaken periodically in order to bring them up to date and make them responsive to changes in legislation. Such a revision is now in progress in the course of which representatives of the Bureaus of Accounts, Statistics, and Valuation have been meeting with the special committee on revision of the Railway Accounting Officers' Association and also with that body's committee on general accounts.

Formal and Informal Cases—Traffic

Our Bureau of Formal Cases in one year disposes of some 1,500 complaints by means of formal proceedings. During the same period informal adjustments brought about through our Bureau of Informal Cases of matters which otherwise would develop into formal complaints numbers approximately 8,000. These adjustments are brought about by means of correspondence with the parties at interest or by conference with appropriate committees or other authorized representatives of the different parties.

Our Bureau of Traffic is constantly settling through informal negotiations controversies between shippers and carriers which otherwise would result in litigation. The bureau realizes the great difficulties under which carriers labor in preparing rates and regulations for publication in a manner which will meet the numerous requirements of law. In examining tariffs the policy is followed of directing attention to all apparent infractions of the law or the rules with suggestions intended to be helpful as to how such practices may be corrected and avoided in future at minimum expense of time and money to the interested carriers. In granting authority to publish rates on short notice and to waive the ordinary rules of publication to meet emergencies, the bureau deals in a sympathetic way with the problems and difficulties met with by the carriers and follows as liberal a policy as possible subject only to reasonable safeguards against discrimination as between shippers or carriers. Full opportunity is afforded by the officials of the bureau for personal conference with officers and agents of the carriers with respect to any of the various applications continually filed by them. Where it is not possible under the law to grant precisely what the carriers seek, it is the practice of the bureau to indicate other forms of relief which may adequately meet the needs of the carrier and yet be consistent with the law. A number of employees of the bureau are constantly engaged in the examination of tariffs with a view of suggesting plans to the carriers for simplifying such publications, so that they will be less expensive to print and file and will, when filed, more clearly and adequately state the rates, thus eliminating one important source of loss to carriers, namely, overcharge claims resulting from ambiguous tariffs and from the accidental publication of rates and privileges not intended.

In matters relating to tariffs, as with other matters, the carriers and shippers maintain appropriate committees covering such important factors as tariff publication, weighing, demurrage, reconsignment, and similar matters so that the work may be handled promptly and unnecessary expense and litigation avoided. The rules for the publication, filing, and posting of tariffs were devised after consultation with experts of the carriers. No changes are made in such rules without opportunity being afforded carriers to make suggestions, and such suggestions are followed in so far as consistent with the public interest and the Commission's duties under the law.

Service

Our Bureau of Service through its force of service agents is constantly holding conferences with shippers and carriers, arranging for service, adjusting disputes, and handling matters which otherwise would result in complaints and litigation.

As an illustration of some of its activities, it is at present conducting, in connection with the Department of Agriculture, co-operative tests on lines of different carriers to determine the best method of furnishing protective service to perishable freight. In these tests the Commission and the Department of Agriculture furnish the necessary force of experts, the carriers furnish the equipment and such special facilities as may be needed, and the shippers prepare or load the commodities in accordance with the wishes of those in charge of the tests. The tests consist of actual movement of various perishable commodities from coast to coast in the regular trains equipped with necessary instruments to record temperature and other important details. By such means disputes are adjusted, just and reasonable rules, regulations, and practices established, better protection is given to perishable products, and better service rendered to the public.

The Bureau of Service also conducts quarterly conferences, followed by hearings, in connection with the administration of the act for the safe transportation of explosives, and is in constant contact with the Tank Car Committeee and other committees of this association working out by co-operative means methods of meeting the requirements of the law and improving the service.

In this, as in other matters, the attitude of the carriers is one of helpful co-operation. Prior to the enactment of the car service act car shortages were so common that they they almost became chronic; determined efforts were made by the carriers and the Commission to cope with them by the organization of general committees, but such committees were without authority to enforce their regulations. Immediately following the passage of the act a Bureau of Car Service was organized by the Commission for the express purpose of handling matters relating thereto in co-operation with a similar

bureau organized by the American Railway Association. Between those two bureaus the most cordial relations and the most complete co-operation exist. Both are working constantly to provide better service for the public. So long as the railroads with their organization can solve the problems and provide satisfactory service, they handle the matter without interference, as is their duty under the law to do. When problems arise which, because they require modifications of the car service rules, priority in transportation, movement of traffic under permits, or similar matters, cannot be handled by the American Railway Association bureau, our Bureau of Service steps in and under the authority conferred by the law takes charge of the situation and handles it in the interest of the public.

In all matters relating to transportation of explosives joint committees composed of the committee created by this Association, the railroads' Bureau of Explosives, and our Bureau of Service hold regular conferences to devise better and safer methods of handling dangerous commodities. Regulations are amended or changed as conditions require only as the result of such conferences.

Safety

Our Bureau of Locomotive Inspection and Bureau of Safety, in connection with the preparation of rules covering appliances required by the various acts, hold conferences with the carriers and endeavor by agreement to establish proper standards which, when approved by the Commission, are to be observed as meeting the requirements of the law.

Accident investigations are conducted jointly with the representatives of the carriers and the representatives of the State Commissions. When making inspections of equipment, the proper representatives of the various departments of the railroads are invited to accompany the Commission's inspectors so that results may at once be known to the proper official and any improper conditions found may be promptly remedied.

This Association maintains standing committees, which are always available, to meet with the representatives of our bureaus to consider necessary changes in rules or practices to promote safety and meet changed conditions or bring about an improvement.

It is true that in some cases prosecutions are necessary and, as stated by the Commission in its third annual report, when necessary they are instituted, but it has been demonstrated that with a proper spirit of co-operation far more prompt and effective results can be obtained by conference between the appropriate committees representing the different interests and the proper officers of the government. And where the parties to such conferences can discuss the problem before them with open minds, having in view solely the best interests of all, it is rare indeed that a reasonable solution cannot be reached.

I am not unmindful of the fact that in the early days there was very substantial opposition to the regulation of railroads by law and a failure to respond to the efforts of the Commission in the direction of co-operative administration. This was probably due to the thought widely prevalent at that time, and which exists to a limited extent today, that the railroads are private property which should not be regulated by law. That theory, however, is no longer accepted by anyone who has given the subject careful study and is familiar with the decisions of the courts and the results of regulation that have been obtained.

Results

And now a word as to the results. It is not possible on an occasion of this kind to make more than a general statement, but if the results indicate anything it is that since the beginning of railroad regulation the treatment applied has on the whole been sensible, wholesome and constructive. I shall not attempt to quote the figures but they amply support the statement that the results have been greater safety, greater efficiency, better service, better credit, better financial condition of the railroads as a whole, and has given a stability of value to the capital invested in railroads which it never before had.

This association, organized in 1869, has been the pioneer amongst railroad organizations in the development of standardization and co-operation amongst the railroads and between the railroads and the different departments of government charged with the administration of law. There is much in its record of which you may feel justly proud.

Passenger and Freight Car Design

By Victor Willoughby
General Mechanical Engineer, American Car and Foundry Company


V. Willoughby

The transportation facilities of a nation have always provided an accurate gage of its prosperity. The solving of a transportation problem calls for a careful analysis of the products or people to be transported, length of haul and density of traffic. Not many years ago we were almost entirely dependent upon railroads or steamships as our transporting mediums over any except the shortest distances. The advent of the motor truck has materially changed the short haul freight problem, while the privately owned automobile, together with the bus lines, are giving all except the long-haul freight and trunk line passenger service a hard struggle for existence.

The automobile has probably been one of the best educators that has ever been invented and its use has so stimulated passenger travel that our desires are becoming more and more cosmopolitan. Take the dining table of today versus that of 30 or 40 years ago and you will find on even the most humble table products from all over the world. These were luxuries three or four decades ago; today they are felt to be absolute necessities. All this means additional traffic for our transportation facilities to handle and the equipment must be that most suitably adapted for its traffic.

Refrigerator Cars

The refrigerator car must take the melons of Colorado or California, place them in New York or Boston in the pink of condition, and the charge for this service must not be exorbitant. Every pound dead weight which this car contains entails the use of extra energy for its transportation. This energy comes from the coal pile. Therefore, one of the car designers first problems is to keep the weight of the car as low as possible, all things considered.

In order to deliver perishable produce in the pink of condition it must be kept during the days which it is being transported within a narrow range of temperature both day and night, even though the outside temperature may vary as much as 50 to 80 deg. Two important elements of design enter into the proper

maintaining of this temperature: (a) the refrigerating agent, and (b) proper insulation of the car.

The refrigerating agent in general practice is melting ice. The cost of this is a transportation charge against the product and may be divided into several parts, such as cost of the ice and salt; cost of handling the ice; transportation of this ice, it being an additional dead load; and the damage that the salt water can do to the car and the roadbed. Therefore, in designing this car it is extremely important that care be taken to conserve so far as possible this refrigerating effort by proper insulation.

Take the design of the insulation; laboratory tests have been made on a large variety of insulating materials. These tests are useful, but are reliable guides only insofar as the insulating material is applied to the car in such a manner that it will stay where put. A new wooden-frame refrigerator car with all joints between the insulation tight and connections between outer and inner walls properly insulated, will give results very close to those indicated by laboratory tests. If, however, in the course of operation the joints open up, insulation slips from place, leaving open spots, then the efficiency of the car deteriorates rapidly.

The designer must be careful to see that his construction is such that this insulation will stay where put during the normal life of the car. In doing this he must not overlook the element of weight, because every pound increase in dead weight means a certain amount of coal wastefully used.

Thus, due consideration must be given when deciding upon the kind of insulation as to its insulation value versus its weight, versus the ease with which it can be properly secured in a car structure, versus its susceptibility to moisture, and its relative cost weighed against all these elements. A refrigerator car designer has to take all these factors into consideration if he hopes to have a design that will successfully compete in the transportation game. He even should go further and consider the color of paint used on the car, especially the roof, as this has a large influence on heat radiation and heat absorption.

Box Cars

Taking the box or house car, first consideration must be given as to what product is most likely to be hauled. The designer who does not consider the predominating commodity that the car has to transport, giving this first consideration, then carefully weighing all other requirements, is not going to produce a design of which there will be many repeat orders.

One type of freight car which today is undergoing the greatest transition and to which more than its share of attention is being given, is the tank car. Commodities formerly shipped in glass bottles or in carefully crated small containers, are today transported in tank cars.

The Container Car

Another special car which we feel is going to be used extensively when its advantages are appreciated is the container car. Where a manufacturer has consignments to several customers, none of which equal a carload, but which, on the other hand, are shipments equivalent to one-sixth or one-fourth of carload, will have delivered to his factory containers in which he can (for instance, if he is a shoe manufacturer) pack his product in the ordinary individual pasteboard boxes without the expense of cartons or packing boxes now used in l. c. l. shipments. He will fill this container with shoes in the same boxes in which they will appear on the retail shelf, seal this container, have it taken to the freight yard, loaded on a specially prepared car and transported to destination. There the container is lifted bodily from the car and trucked to the customer's receiving platform and unloaded, the container being returned to the car and sent back for the next shipment. In this manner material necessary for manufacturing crates, which, after they are once used, are generally destroyed, is eliminated, together with a marked reduction in the handling of the goods and a big reduction in the possibility of damage to the goods. This scheme of transportation is in its infancy, but indications are that its advantages are being appreciated and we can look in the near future for a marked increase in container car shipments.

In the chlorine industry there are a number of cars designed to carry 15 steel cylinders, each of which holds one ton of liquid chlorine. These cylinders can be removed, empty cylinders placed back, and the car returned for reloading.

The reduction of dead weight is a problem that is being given serious attention. As one instance, note the one-wear steel wheel. Considerable study is also being given to the use of alloys with the hope of utilizing metals of higher strength, and thus effect a saving in dead weight.

As stated, the privately owned automobile and the bus have made great inroads in passenger traffic, especially over moderately short hauls. In congested districts, of course, there is no room for the automobile to handle the masses, with the result that we have highly specialized elevated and subway systems. The study and design of this type equipment is a job in itself.

Serving the largely populated centers we have commutation trains, again a specialized traffic. Large numbers must be carried quickly and the service absolutely must maintain schedules irrespective of weather conditions. The periods of dense traffic in this service extend over only a few hours of the day, one way in the morning, the other way in the evening. However, reasonable service must be given during the balance of the day. Cars for this service must be comfortable, of large capacity and be of as light weight as possible consistent with safety.

Suburban Passenger Cars

Many suburban car designs have been developed, some of which adhere closely to the road's coaches for through service; others are highly specialized, some incorporating large or numerous doors to permit quick loading and unloading. One road serving Chicago is building a number of cars incorporating a large amount of aluminum, thus effecting a marked reduction in weight. Another road also has in experimental service on one of its lines entering Philadelphia cars utilizing aluminum and its alloys to quite a marked degree. It is a little early to pass on the extent to which aluminum can be successfully utilized in passenger train cars.

Remote branch line service has been hardest hit by the automotive vehicle. The truck is here the freight competior, while the bus and privately owned automobile have made great inroads in the passenger travel. It is still necessary, however, that the roads operate these branch lines, and, as a result, we have the self-propelled car development as an answer to this problem. Here again the designer is called upon for highly specialized product. Extreme care must be given to the question of weight, and the designer who does not carefully analyze every detail which goes to make up the structure of his car, is either going to have one too heavy to be economically operated or else a structure which will have weak parts and will fail during service.

Passenger Coaches Too Heavy

The main line passenger car for through service has been influenced less than any other by the automotive vehicle. The designer of this type af equipment, however, must give more consideration to attractiveness and comfort than in the past. Passenger coaches of today are entirely too heavy and cannot be operated as economically as they should be. True, first consideration should be given to safety. Even safety, though, can sometimes blind one to the proper evaluating of the elements entering into the design. The usual construction of a main line coach of today is built around a heavy built-up center sill member known as fish-belly or shad-belly sill, which is in reality like a backbone to the car. This is a perpetuation of the construction used in earlier stages of development, when steel underframes were placed under wooden bodies. At that time it was necessary that the steel underframes have sufficient strength and rigidity to carry the car body and the liveload, as well as resist the buffing and pulling stresses.

When the use of steel was extended from the underframe to include the entire structure of the car, most designers still retained the heavy center sills. In the earlier designs of the all-steel car, the load-carrying members were the center sills, assisted by that portion of the side frame from the belt rail down to the side sill, while the buffing shocks were resisted by the center sills only. The superstructure of the car above the belt rail was considered as so much dead weight. When the posts were light rolled sections with little rigidity, this analysis was partially true. However, with the development of pressed posts and especially the use of box section posts the side frame becomes not a girder, whose depth is that of the belt rail down to the side sill, but the entire framework of the car is something after the fashion of a tub and it is logical to consider that the steel roof sheets, purlines, deck, side plate and letterboard all form the load-carrying member of the car and that they also, in a limited way, contribute to its shock-resisting strength at the time of a collision.

Does Unlimited End Strength Promote Safety?

For easy computation quite a few designers consider the side frame of the car; that is, side plate, letterboard, the belt rail, side sheathing, and the side sill as the carrying member of the car. Here you have a girder between 7 and 8 ft. in depth, which has in itself ample strength and rigidity to carry all the vertical loads to which the structure will be subjected, and yet not exceed in weight, size or thickness that which it is necessary and logical to use to perform its primary function of protecting against the elements and form a support for the car roof.

A great deal of stress has been placed on making the end

of the car so strong that in case of collision the car will not be penetrated. The writer believes that if the end is made too strong the shock from the impact will be such as to throw passengers around in a way to cause more damage than if the car end was not so rigid, but was symmetrically attached so that in case of a collision the vestibule will fold up or crumble and absorb, to a large degree, the force of impact due to collision and cushion the blow. While the car itself may be damaged a little bit more, passengers will be much better protected, which, of course, is the first duty of the car structure.

I have tried to point out a few of the aspects of car design encountered every day. These are additional to the purely engineering computations necessary to determine strength of individual members. We, as builders, of course, see the question of design from a different angle than you who operate and maintain the cars during service. In many ways our problems are the same. The structure which lends itself most readily to ease of maintenance is generally a construction which is easy and economical to build. Because of the necessity of maintaining existing standards, thus keeping to a minimum the repair parts necessary to carry, it is not always economical to utilize the best construction. This is a feature of which the railroad engineer should be the best judge. However, simplicity of design, as few parts as possible, and reduction of weight consistent with serviceability should always be carefully weighed against savings that can be effected by maintaining existing details. Often it is wise to cut loose from existing details and establish new designs for railroad cars.

The question of excessive dead weight is, in the writer's estimation, a vital one and one that should be attacked from every angle, from scrutinizing the size of the smallest detail up to the use of special materials, keeping in mind that every excess pound in the weight of the car will be ton-miles of dead load carried before the car has served its day.

Report on Safety Appliances

By H. A. Johnson

Director of Research in Charge of Power Brake Investigation

Underwood & Underwood

H. A. Johnson

The investigation of power brakes and appliances for operating power brake systems has been carried forward during the year and the director of research is able to report substantial progress. The 1926 report covered the reasons for the investigation; the agreement to a general plan of procedure by the committee on Safety Appliances of the Mechanical Division of the A. R. A. and the Bureau of Safety of the I. C. C.; the appointment of a director of research; the reconstruction of the A. R. A. test rack at Purdue University, including the development and building of new test instruments; the placing of orders with the Automatic Straight Air Brake Company and the Westinghouse Air Brake Company for 150 sets of freight train air brake equipments which will meet the tentative specifications and the I. C. C. requirements; the preparing of a schedule of tests which was agreed to by the interested parties; the building up of an organization of trained men to carry on the work.

The test rack was first equipped with new standard Westinghouse type K triple valves. The tests on these valves started on November 30, 1925, and were completed on June 30, 1926. During this time more than 600 tests were run and it was necessary to stop the tests three times for cleaning and lubrication of the triple valves. Upon the completion of the tests, the type K equipments were entirely removed from the test rack and the Automatic Straight Air Brake Company's equipments installed. These equipments had been received at Purdue University about April 1, 1926. The equipments purchased from the Westinghouse Air Brake Company were received July 1, 1926.

After the installation of the A. S. A. equipments was completed, the test rack was turned over to the representatives of this company and they made such preliminary tests as they deemed necessary to satisfy themselves that their equipments were in proper condition and were ready for the official tests. The tests on this equipment started on August 17, 1926, and are still in progress. This equipment has been submitted to more than 600 tests, including single triple valve tests, 100-car train tests representing level road conditions, 100-car train tests representing grade conditions and 50-car train tests representing grade conditions. Since starting the tests on the A. S. A. equipments, it has been necessary to stop three times to clean and lubricate or make adjustments of the mechanism.

The Automatic Straight Air Brake Company claims that their equipment is superior to the Westinghouse type K equipment and possesses the following new functions:

1—That only a service application of the train brakes will occur when a service reduction of brake pipe pressure is made.

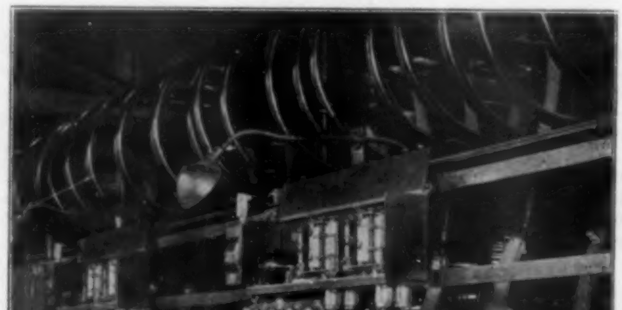
2—The ability to obtain effective emergency brake cylinder pressures after a full service application or after release following a full service application of the brakes.

3—The ability to maintain brake cylinder pressure against ordinary leakage.

4—The ability of the engineman to control the release of pressure from brake cylinders and effect such release by graduated steps in order that he may decrease as well as increase brake cylinder pressures as required to control at relatively uniform rates the speed of trains.

The series of tests with all cars in the train equipped with the Automatic Straight Air Brake Company's equipments will be completed during the first half of April, 1927.

Following this the A. S. A. equipments will be removed from 50 of the 100 cars and the Westinghouse standard K equipments replaced on these 50 cars so that 50 cars of the 100 car train will be equipped with A. S. A. equipment and the remaining 50 cars of the 100 car train will be equipped with Westinghouse type K equipment. In the first half of the train, the two kinds of equipments will be alternated every five cars and in the last half of the train they will be alternated every 25 cars. When the test rack has been set up in this manner, a series of tests will be made for the purpose of showing the effect of each type of equipment upon the other, or, in other words, to determine if the Automatic Straight Air Brake Company's equipments will operate harmoniously with the type K equipments in the same train. It is obvious that a new air brake equipment could not be adopted for freight cars in interchange unless it was designed so that it would function satisfactorily when operated in the same train with the standard air brake equipment.



Test Rack Equipped with Automatic Straight Air Brakes

The Westinghouse Air Brake Company has submitted for trial

two new air brake equipments; one of which, it is claimed, complies with the tentative requirements and specifications of the Interstate Commerce Commission as stated in its preliminary report and conclusions dated July 18, 1924, and the other equipment contains the ideas of the Westinghouse Company on the desirable functions of an air brake equipment for long freight trains. After the completion of the tests on the A. S. A. equipment, the two new Westinghouse equipments will be placed upon the test rack in turn and submitted to the same series of tests as the A. S. A. equipments, including the tests to determine whether these equipments will operate harmoniously with the present standard type K equipments.

Two inspection days have been held during the conduct of this investigation when all the members of the Mechanical Division of the A. R. A. were requested to send representatives to witness the performance of the brake equipments upon the rack and to become acquainted with the method of carrying on this investigation. The first inspection day was May 12, 1926, when the standard type K equipments were on the test rack. The second inspection day was November 12, 1926, when 150 men representing 65 different railroads and 10 other companies and associations observed the operation of the A. S. A. equipments on the rack representing a 100-car train.

During the year the research organization has been considerably increased. The results are being calculated and tabulated as the tests proceed. One part of the organization runs the tests and the other part of the organization works up the results. The tabulation and analyzation of the vast amount of information from the trainagraph records has proved to be a large task. The organization now comprises 70 men; approximately three-fourths are engaged in working up the records and one-fourth engaged in carrying on the test work in the laboratory.

Purdue University is doing a large amount of engineering and agricultural extension work which brings many meetings of associations and many visitors to the University. These visitors are from all walks of life, representing farmers' organizations, industrial organizations, bankers and business men. All of these delegations visit the air brake research laboratory and are greatly impressed with the work being carried on by the Association in the interest of greater safety and reliability of train operation. This publicity is very far reaching in the building up of good will toward the railroads. The Bureau of Safety of the Interstate Commerce Commission has maintained from one to three representatives at Purdue University since the air brake tests started and these representatives make daily reports to the Director of the Bureau of Safety, keeping him in constant touch with the progress and the results being obtained. Similarly, the Automatic Straight Air Brake Company and the Westinghouse Air Brake Company have their representatives present at all times and they also make daily reports to their companies on the work accomplished.

An invitation is again extended to all railroad men to visit the power brake laboratory at any time.

Report of Loading Rules Committee

R. L. Kleine
Chairman

As a result of investigations conducted throughout the year with various types of loads and conferences with the shippers, the committee submits the following recommendations for changes in the rules for approval and submission to letter ballot for adoption by the association.

General Rules for Loading Materials

RULE 4

Proposed Form—Cars should be in such condition that the trucks can curve freely and the side-bearing clearance must not exceed $\frac{5}{16}$ in. per side-bearing *per truck and must not be less than ⅛ in. per side-bearing per truck.*

Explanation—Limits for side-bearing clearance in this rule have been changed to conform with the A. R. A. Standards, and the maximum of $\frac{5}{16}$ in. per side-bearing for loads 10 ft. high or over from the top of the rail has been eliminated. Difficulty is frequently experienced under the present rule in getting down to the $\frac{5}{16}$ in. clearance on cars with cast steel truck bolsters and cast steel body bolsters having the center plates and side-bearings cast integral.

RULE 34, FIRST PARAGRAPH

Proposed Form—Ladnig must be secured in closed cars so that it will not come in contact with side doors or roll or shift in transit, and must be so placed in car that there will not be more weight on one side of the car than on the other. *Where the lading is in small units such as bars of bullion or spelter it must be distributed generally over the car floor and if loaded in piles the height of piles must be restricted so that a general distribution of weight is obtained.*

Explanation—A number of derailments have been reported where bars of bullion or spelter have been loaded in piles concentrated along the sides of car and the load became unbalanced due to the piles tipping over.

Group I—Lumber, Ties, Etc.

RULE 156

Proposed Form—It is proposed to omit from this rule the requirement that ends of ties projecting into the doorway must be elevated by a bearing piece laid crosswise of car.

Explanation—Experience has proven that elevation of the ends of the ties projecting into the doorway is not essential to the safety of the load.

Group II—Structural Material, Plates, Etc.

RULE 202, PAGE 82

Proposed Form—The following sentence is recommended for addition to this rule: "Lateral shifting or creeping of the plates must be prevented in some effective manner, preferably by placing stakes in the outside stake pockets or by clamping similar to that shown in Fig. 45."

Explanation—Experience with shipments loaded diagonally with one side resting on the car side indicates that these plates will occasionally work out over the side of the car and the proposed requirements for preventing this condition is a necessary safety measure.

RULE 212

Proposed Form—Large girders, loaded as shown in Fig. 52, must be secured to carrying car, as per Fig. 49.

The blocking used *must be at least* 8 *in. wide and of sufficient height to keep lading at least* 4 in. above floor or end gates *of idler car, for bearing blocks,* and 2 in. by 8 in. in section for spacing blocks, and 4 in. by 6 in. in section (hardwood) for top clamping pieces. The vertical rods must not be less than 1 in. in diameter, and must, if possible, pass through the blocking and the floor of the car. With loads 24 in. high or over, braces must be added as shown in Fig. 53. If the rivet holes are not available, longitudinal motion must be prevented by using clamps. See Fig. 49.

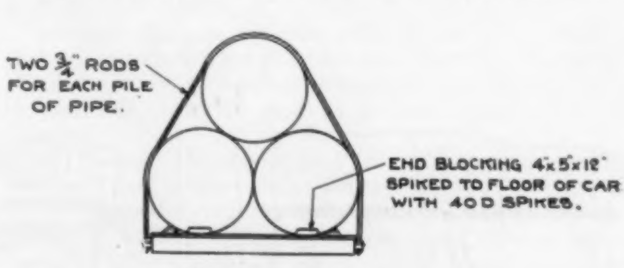


Fig. 81-G—Loading Wrought Pipe 49 in. to 72 in. in Diameter on Flat Cars

Explanation—In this rule, which covers single overhanging loads of girders, the dimension for the height of the bearing-blocks has been omitted and a requirement substituted that the height of the bearing-blocks must be sufficient to keep the lading at least 4 in. above the floor or end gate of the idler car. The

width of 8 in. for the bearing-blocks has been retained. The dimension for the bearing-blocks shown on Fig. 52 for these loads will be changed accordingly. The change is made to conform with the actual practice in loading.

Rule 230

Proposed Form—Long flexible material, like plates, etc., which can not be loaded as shown in Fig. 55, must be loaded on two bearing-pieces, and two or more sliding-pieces as in Figs. 63, 65, 66, 67 and 68. The sliding-pieces must be 4 in. lower than the bearing-pieces *except where the lading will be damaged by permanent deflection, in which case the sliding-pieces may be 2 in. lower than the bearing-pieces.* Sliding-pieces must be equipped with flat metal plates ¼ in. by 6 in. for loads of 40,000 lb. or less, and ½ in. by 6 in. for loads over 40,000 lb.

Rule 249, First Paragraph

Proposed Form—There should be not less than three pairs of stakes to each pile, when the material is 23 ft. or less in length, ***and the height of the load does not extend over 3 ft. above the top of the car sides. When the pile is more than 3 ft. above the top of the car sides, four pairs of stakes must be used. For pipe 23 ft. and less than 30 ft. in length,*** four pairs of stakes must be used when the pile extends above top of car sides. *Material 30 ft. in length or over, when the load extends above the top of the car sides, must be secured by not less than five pairs of stakes.* The top of each pair of stakes should be held together by not less than six strands equal to three wrappings of good ⅜ in. diameter wire resting on pipe, in addition to any intermediate wiring or dunnage strips for the character of the shipments as provided for in succeeding paragraphs.

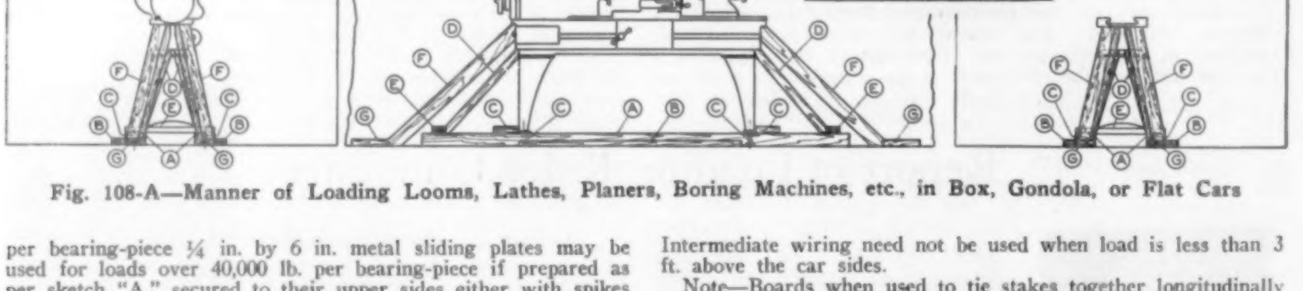


Fig. 108-A—Manner of Loading Looms, Lathes, Planers, Boring Machines, etc., in Box, Gondola, or Flat Cars

per bearing-piece ¼ in. by 6 in. metal sliding plates may be used for loads over 40,000 lb. per bearing-piece if prepared as per sketch "A," secured to their upper sides either with spikes or lag screws at each end. These metal plates are intended to facilitate curving and must be coated with grease before the lading is placed upon them. *The total length of the plates should be such that they project beyond each side of the lading a distance equivalent to the figures shown in last column of the tables under Rule 30, for the respective loads.* The bearing-pieces must be secured to the car in the manner described in General Rules Nos. 26 and 27, and the material must be clamped together in the manner described in Rule 231 to prevent it from shifting.

Note—The metal sliding plates used in connection with twin or triple loads of flexible material should be greased at interchange points to facilitate the curving of the cars.

Explanation—This rule has been revised to permit the use of sliding-pieces 2 in. lower than bearing-pieces in place of 4 in., at the shipper's option. The modification was made at the request of a large shipper who received complaints that certain material takes a permanent deflection when sliding-pieces 4 in. lower than the bearing-pieces are used. Trial shipments followed through to destination indicate that this method can be safely followed under the conditions prescribed.

A provision is also added to regulate the length of metal plates on the sliding-pieces to meet the actual requirements based on the length of load and location of bearing-pieces. The present rule requires that the metal plates extend 22 in. beyond each side of lading for all twin and triple loads. By regulating the length of the plates to suit the load, material will be saved the shipper without any decrease in the security of the load on the car.

Intermediate wiring need not be used when load is less than 3 ft. above the car sides.

Note—Boards when used to tie stakes together longitudinally with the side of the car, must be secured to the inside of the stakes and must not, under any circumstances, be nailed to the outside of the stakes.

Explanation—This rule is revised to require five pairs of stakes for pipe 30 ft. or over in length when the load extends above the car sides. Experience of the railroads with numerous shipments of this pipe has demonstrated that the additional stake requirements are necessary.

Rule 251-A

Proposed Form—It is proposed to add another figure to this rule (Fig. No. 81-G) to cover wrought pipe 49 in. to 72 in. in diameter loaded on flat cars.

Explanation—A number of shipments of wrought pipe in the above sizes are being offered the railroads and the shippers have requested that a rule be provided to cover them. Shipments in accordance with the proposed method have been followed up in service and found satisfactory.

Fig. 108-B—Manner of Loading Light and Heavy Machinery in Box, Gondola, or Flat Cars

Group III—Machinery

Rule 309

Proposed Form—Heavy machinery such as looms, lathes, planers, boring machines, etc., **should, when practicable, have the legs removed and the heavy portion of the machine placed on the floor of the car.** Each machine when so loaded, should be blocked by securely bolting or nailing to the floor of the car one 2 in. by 4 in. hardwood strip at each end, full width of the machine, backed up by three 2 in. by 4 in. by 12 in. **cleats**

and one 2 in. by 4 in. cleat on each side one-half the length of the base of the machine, securely nailed to car floor to prevent side shifting.

When such machinery is loaded resting on legs, the machine should be supported by skids placed under the legs and the legs secured to the skids by bolts, lag screws, or cleats, and one 2 in. by 4 in. cleat on each side one-half the length of the skid, securely nailed to the car floor to prevent side shifting, and in addition, two 2 in. by 4 in. braces should extend to each end from the skids to the heavy portion of the machine, these braces to be backed up by one piece, 2 in. by 4 in. extending across the skids. The top of the machine should be securely braced at each end with two 4 in. by 4 in. hardwood braces bolted or otherwise securely fastened to the body of the machine, the braces extending to the car floor and securely nailed to the floor, backed up by cleats. In no case should the legs or skids be secured to the car floor. See Fig. 108-A.

If the end braces cannot be efficiently employed, the top of the machine should be secured at each end by means of a horizontal beam not less than 2 in. by 6 in. running across the car and fastened securely to the sides of car with suitable blocking. See Fig. 108-B.

The legs when removed from such machinery must be crated.

Light machinery, when practicable, should be crated, the legs removed and secured in the same crate. Where the legs cannot be removed, such machinery will be loaded in the same manner specified for heavy machinery with the exception that a 2 in. by 4 in. end bracing will be permissible in lieu of 4 in. by 4 in. as specified.

Note—Top heavy machinery must be securely tied or braced to prevent toppling over.

Explanation—Rule 309 covering the loading of machinery has been completely revised to provide for loading on skids. The present rule has proven inadequate for shipments of this character.

Group IV—Concrete Pipes, Brick, Etc.

Rule 400

Proposed Form—The manner of securing concrete culvert pipe loaded on flat cars; pipe loaded on its side should be secured as per Figs. 109, 109-A or 109-B, the method shown on Fig. 109-B to be followed for pipe loaded crosswise of car, when cars are not equipped with end stakes pockets. *Pipe loaded on end should be secured as per Fig.* 110, *and where the diameter exceeds* 48 *in. the pipe may be placed on the floor with the bell end upward.*

Explanation—The rule has been modified to permit concrete culvert pipe over 48 in. in diameter to be loaded on the end with the bell end upward, whereas under the present rule, all pipe loaded on end has the bell on the floor.

Rule 400, Second Paragraph

Proposed Form—Pipe 12 in. to *and including* 32 in. in diameter to be loaded in pyramidal form as per Figs. 110-A and 110-B.

Explanation—The wording has been changed to clarify the intent of the rule, making it clear to the shipper that 32 in. diameter pipe is included in the sizes to be loaded in pyramidal form.

Rule 410

Proposed Form—First Paragraph: It is proposed to insert the words "flat cars" in the first line so as to confine the paragraph to flat car loading.

Third Paragraph: It is proposed to modify the first sentence to read as follows: "Gondola cars are preferable for such shipments *and when used, no blocking is necessary*, but if flat cars are used, the lading should be placed at least 18 in. back of the end of the car."

Explanation—The wording of these two paragraphs is changed to clarify the intent of the rules in regard to methods of loading large stone on gondola cars as compared with flat cars.

Side Stake Pockets for Flat Cars

It has come to the attention of the committee that a number of flat cars suitable for twin shipments have side stake pockets with the opening considerable less than the A. R. A. recommended practice of 4 in. wide by 5 in. deep. These under size stake pockets, for example 3 in. wide and 3¼ in. deep, necessitate so much trimming down of the side stakes that the stakes are greatly weakened and frequently fail in service at this point. This applies particularly to green saplings where the outside wood is trimmed away. To overcome this trouble the following recommendation is submitted.

Recommendation—Add the following paragraph to Interchange Rule 3 (f)—"Flat cars suitable for twin loads should have stake pockets 4 in. wide by 5 in. deep. In interchange."

This report is signed by R. L. Kleine (chairman), Penn.; R. H. Dyer, N. & W.; E. J. Robertson, M. St. P. & S. Ste. Marie; Samuel Lynn, P. & L. E.; G. R. Lovejoy, Detroit Terminal; T. O. Sechrist, L. & N.; C. J. Nelson, Chicago Car Interchange Bureau, and R. B. Rasbridge, Reading.

Discussion

R. L. Kleine: After the report was printed we received several suggestions from Mr. Sillcox. The first was that the wording of Rule 4 be changed to correspond with the A. R. A. Manual, Section C, Page 3.

The paragraph should preferably be worded thus:

"Rule 4. Cars should be in such condition that the trucks can curve freely and the side-bearing clearance must not exceed an average of 5/16 inches per side-bearing per truck and must not be less than an average of ⅛ inch per side-bearing per truck."

The wording will be changed to conform to the A. R. A. Manual, as suggested, when incorporated in the letter ballot circular.

The second suggestion is on Rule 34. The underlined portion should contain specific directions that the lading, such as bars of bullion or spelter, be anchored so that they will not move en route.

Your committee feels that the experience with these shipments does not indicate that any blocking or bracing to hold the lading is necessary. This material is placed in piles in order to get a double check on the contents and to facilitate unloading. Some trouble has developed where the material is piled too high and tipped over. The recommendation of your committee will be that those piles should be kept low.

Page 13, last item, contains a recommendation to have interchange Rule 3, Section F, amended to require:

"Flat cars suitable for twin loads should have stake pockets 4 inches wide by 5 inches deep. In interchange."

Such an amendment would be rather drastic and should not be incorporated without giving some extension of time to allow the car owners to comply. The stake pocket referred to has never been adopted by the A. R. A. standard, but is contained in the lists of recommended practices, which leads me to believe that railroads generally have not followed it. The rule should contain a definite date, as for instance, effective Jan. 1, 1930.

Another phase of the side stake pocket proposition is that the recommended practice says nothing whatsoever about the stake pocket being tapered. It might be well to have this corrected to show at least ¼ inch taper in 7 inches.

Mr. Tatum: During the past year it has been suggested that each part of the rule be written complete, in place of being required to refer over to certain other parts of the rules that govern different loading and apply to other loading. The shippers think if that was done that they would more readily understand the rules, and there would be less differences of opinion between the shipper and the railroad representative in getting the cars properly loaded.

The B. & O. as an individual railroad did not feel that it should print the rules in that form if it could get the association to consider whether or not it would be a desirable thing to do, so that all could get the benefit of it, and all work by one set of rules.

Mr. Kleine: The point is well taken, but there are certain difficulties in the way of carrying out the suggestion as there are certain general rules which must be followed in connection with the detailed rule covering the particular commodity. While it is not impossible to repeat each of the general rules under the individual headings, it will make a book, either two or three times the size of the present book.

However, the committee will be glad to again consider

Mr. Tatum's suggestion and report to the next convention as to whether it is desirable or not desirable to make any change in the present make up of the book.

Mr. Brazier: In loading ties in box cars does the committee recommend doing away with the bearing piece in the doorway?

Mr. Kleine: You are partly right. We recommended doing away with the bearing piece in the doorway of the car, not the bearing piece at the end of the car. The ties at the present time are raised in the end of the car on a bearing piece.

T. C. Armstrong (C. P. R.): Do I understand that the loading of steel rails on flat cars does not call for blocking?

Mr. Kleine: That is correct.

Mr. Armstrong: I think that is a mistake. It should be blocked.

The report was accepted and referred to letter ballot.

A. G. Pack Comments on Splendid Condition of Power

By A. G. Pack

Chief Inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission

A. G. Pack

The beneficial effects derived through meetings of organizations and associations such as the Mechanical Division of the American Railway Association are recognized without question. The standards established and adopted by your organization are looked upon in the United States and Canada, and probably throughout the entire civilized world, as being of the greatest value along the lines of our endeavor—that of promoting safety, efficiency and economy of transportation of persons and property. The duty of this association, as set forth in the constitution of the A. R. A., is "To consider and report upon methods of construction, maintenance and service of rolling stock of railroads."

Your interest and mine are not unlike. I am particularly interested in safety—safe design, safe construction, safe repair, and safe operation. When this is accomplished it means that the principal source of transportation on the railroads—locomotives—is both efficient and economical, therefore, both go hand in hand.

The progress which you have made may be measured in various ways,—in dependability and speed of service, in cost per unit of transportation, in utilization and in reduction in defects which may result in accidents and serious delay to traffic. With such tremendous responsibilities resting upon your organization in meeting the demands of transportation, one directly responsible for the expenditures of such vast sums of money, one responsible to such a degree for the safety and efficiency of locomotive and car operation, and consequently the safety and efficiency of train operation, it is in my opinion not too much to expect that you be given broad powers in directing the affairs for which you are responsible. Not all of the operating officers have come to their positions with sufficient knowledge and intimate contact with the maintenance of motive power and cars to understand what they should be and what should be expected of them.

If the best results are to be obtained, the service must be rendered promptly and economically, but this cannot be accomplished if the equipment is not in condition to meet the requirements. A few cents per mile added to the necessary cost of maintenance is more than compensated for by the reduced cost of transportation, a basic fact too often overlooked. I know of no one who can estimate with any degree of accuracy the cost to the railroads and the traveling and shipping public of an engine failure or the serious delay to a train.

There is nothing which so adversely effects the economical maintenance of equipment as to disrupt the mechanical organizations at frequent intervals or to fluctuate its personnel with every temporary fluctuation in traffic. Equipment can not be properly and economically maintained if repairs are neglected until the busy season arrives. It is then that it should be in revenue service rather than on the repair track. It is then that the transportation department and the shippers are pressing for motive power and rolling equipment. Therefore, in keeping with good sound business principles, equipment should be repaired during dull periods and be available when rush periods come.

I appreciate that revenues cannot be disregarded in making expenditures, but I believe that with due consideration and foresight expenditures can be anticipated with sufficient accuracy to provide more uniform employment and practices than have heretofore been followed with respect to maintenance of equipment. The required amount of money must be provided and must be spent during the year, whether spasmodically or uniformly. The mechanical organizations of many of the railroads have been seriously embarrassed by being compelled to maintain modern equipment in obsolete shops with antiquated machinery, inadequate tools, insufficient material and material of inferior quality. It is true that there has been a great improvement in recent years in supplying larger shops, better roundhouses and better tools, but I am of the opinion that there is still room for much improvement along this line.

The government's rules are your rules. They represent what was in effect on the railroads prior to being adopted by the government, but not always complied with. If they had been, there never would have been a demand for the Locomotive Inspection Law. I am reminded by this of an incident which occurred soon after the original act and the rules and regulations established thereunder became effective. The general manager of one large system wrote to the then chief inspector that "if the government's rules were enforced, it would bankrupt every railroad in the United States." The chief inspector replied, making comparison with the rules in effect on his line prior to the adoption of the government's regulations, showing that his own rules were very much more stringent than the government's rules. When the same general manager replied, "There is a wide difference between a rule that may be varied from at will and one that becomes law and must be complied with." The failure of the railroads to comply with their own rules is what brought about the law.

The law gives the chief inspector of locomotives, with all of the inspectors appointed under the act, broad powers in seeing to it that the rules and standards

adopted first by the railroads and later by the government are complied with. A law or rule that may be varied from at will according to the judgment of individuals interested, especially so when working under heavy pressure, becomes of little value. It has been too often said "She will make another trip" or "She came in and can go out." It is the next trip that causes the trouble. By proper co-operation and co-ordination of our duties the more punitive measures provided in the law for its enforcement can and should generally be avoided, and I wish it were so that our inspectors would never find it necessary to report a defect on a locomotive, the repair of which had been neglected, or order a locomotive out of service for violation of the law or rules established thereunder. We are not seeking to make a record that will condemn any railroad or to show an inclination on its part to violate the established law, but we are earnestly striving to bring about the safest condition possible and to enhance the earning power of locomotives.

Locomotives throughout the United States during the last fiscal year ended June 30, 1926, were in better physical condition than I have ever before known them, and our records will indicate that during the fiscal year now coming to a close they are even in better shape than the year previous. The Bureau of Locomotive Inspection is getting better co-operation on the part of the railroad officers in the matter of complying with the law and rules than ever before existed, and I am proud of the cordial relations apparent.

The Relation of Physical Factors to Financial Results

By W. T. Jackman
Professor of Political Economy, University of Toronto

W. T. Jackman

The financial returns obtained by a railway company depend upon the general level of freight rates, on the one hand, and upon the operating expenditures and capital charges on the other. The relation of rates to financial returns is immediate and direct; and although by far the larger share of public attention with reference to the railways is given to the freight rates, it is not our purpose here to consider this matter. Instead, we shall confine our attention to the other aspect of the problem, namely, the relation of the physical elements of operation to the financial results.

Public interest is frequently centered on the relation of earnings to the railroad capitalization, sometimes because the former are inadequate to meet the demands of the latter and a readjustment of the capital becomes necessary, and at other times because, notwithstanding many difficulties, the railway companies are able to pay reasonable dividends and expand with, and occasionally in advance of, the growth of the country. But it is much less frequently that one finds any consideration given by people generally to the relation of earnings to the value of the physical plant by the use of which these earnings are obtained.

An Analysis of the Operation of 10 Roads

In order to give a conspectus of the present problem with the necessary background for appraising it, we have worked out the accompanying table with some degree of elaboration from the actual figures presented in the annual reports of ten important railways of the United States and Canada. We have used the figures for the year 1910 as a base, because this was a year of approximately normal development, and have traced the changes through the period of the war and of the subsequent restoration. On the basis of 100 for the year 1910, we have expressed the facts for succeeding years in terms of percentages of those for 1910. It will be recognized that a composite picture obtained from the returns of many railroads, operating under a wide diversity of conditions will give a more exact foundation for our analysis than could be obtained from the facts pertaining to only one or two railroads.

Having this table before us, let us note some of the important facts which may be adduced from it.

First.—With an increase of 62 per cent in the number of locomotives and an increase of 90 per cent in the number of freight cars, the amount of service rendered, i.e., the number of ton-miles of freight carried, increased 142 per cent, although the density of traffic, i.e., the number of ton-miles per mile of road, increased only 33 per cent. This gives a clear indication of the more intensive use of the rolling stock at the later than at the earlier time.

Second.—Although the amount of service rendered increased by only 142 per cent, the gross operating freight revenue increased by 310 per cent. This shows the effect of the higher freight rates in the period during and since the war.

Third.—Although the gross operating earnings increased by 286 per cent, the operating expenses increased still more, so that the net earnings from operation increased only 270 per cent. During this period the operating expenses (wages, fuel, materials, etc.) rose proportionately higher than the freight rates charged for the service. Over these operating expenses the railroads have almost no control—wages are determined largely by the labor unions, while the prices of fuel, materials and supplies are almost entirely in the control of those who supply these requisites. With freight rates under the control of the regulative tribunals and the operating expenses in large measure beyond the control of the railroads, it is not surprising that the net earnings from operation have not kept pace with the gross earnings.

Fourth.—A very important thing to note is that while the amount of the service rendered by the railroads, that is, the

Table I—Relative Figures of Physical and Financial Results of Operation of a Group of Ten Railroads* Using the Year 1910 as the Base

Year	No. of miles operated	No. of locomotives	No. of revenue freight cars	No. of passenger cars	Other equipment	Value of railway and equipment	No. of ton-miles of revenue Freight	No. of ton-miles of revenue freight per mile of road	Total freight revenue	Total passenger revenue	Gross operating earnings	Operating expenses	Net operating earnings	Per cent return on value of railway and equipment
1910	100	100	100	100	100	100	100	100	100	100	100	100	100	10.1
1911	100	103	96	101	70	102	104	103	104	99	104	100	114	11.0
1912	100	104	101	101	70	109	112	112	111	104	110	109	110	8.0
1913	99	109	110	106	76	139	122	123	118	112	116	118	112	8.1
1914	99	112	108	114	75	183	106	107	106	105	113	113	111	6.1
1915	147	137	181	123	106	284	190	127	179	126	168	148	222	8.0
1917	150	138	191	122	122	311	243	162	188	157	216	207	242	7.8
1919	160	166	201	143	133	336	217	149	297	237	284	304	227	6.8
1921	161	151	189	128	119	351	160	106	306	253	292	299	272	7.8
1923	182	144	166	114	116	370	245	163	402	270	365	376	335	9.1
1924	182	169	197	139	145	389	227	125	388	302	370	378	347	8.9
1925	183	162	190	137	143	399	242	133	410	304	386	392	370	9.3

* Nine roads in the eastern and central part of the United States and one in Canada.

number of ton-miles of revenue freight carried, increased only 142 per cent and the gross earnings from operation increased by 286 per cent, the investment of capital in roadway and equipment increased practically 300 per cent. This taken in conjunction with the fact noted first above that there has been a more intensive use of the rolling stock, leads to the explanation that this great increase in capital investment was not necessary for the existing business but was made to a considerable extent so that the railroads might be ready to meet any emergency in the way of an unusual volume of traffic which may arise in the near future. The railroads must be constantly preparing for the unexpected. Even under normal conditions the amount of traffic which is offered to the railways increases much more than proportionately to the increase of population; and when the traffic is stimulated or encouraged but slightly the amount of increased business comes with a rush upon the rails. Unless the railway company has made provision in advance for meeting such an emergency, it would be unable to make provision for it at all, for there would be no time for this when the flood of traffic was at hand.

Fifth.—With the exception of a few years during and immediately after the war, when business conditions were disorganized, the net earnings were fairly uniformly 8 per cent and 9 per cent of the value of the railroads' investment in roadway and equipment. Of course, the entire investment of the railway companies does not consist merely of roadway and equipment, but includes a great variety of other elements, such as cash, materials, supplies, accessories, etc., which would, on a conservative estimate, increase the amount of this operating investment by 5 per cent. But before anything can go to the owners of this investment, that is, the stockholders, provision must be made for meeting the fixed charges on the bonded debt, as well as for a variety of reserves which are necessary, and care should be taken to set aside a reasonable surplus to meet unforseen contingencies. If all these demands were adequately satisfied, the amount which the companies could divide among those whose capital provided the operating assets would be small indeed. The return of 8 per cent to 9 per cent upon the railway plant and facilities is entirely inadequate. According to the last report of the Interstate Commerce Commission, issued a few weeks ago, the average rate of return on dividend yielding stock of Class I railroads in 1925 was 6.51 per cent, and if the dividends had been divided out over all the stock of these railroads the return would have been only 4.45 per cent. For the Class II and III railroads the dividends are practically negligible. If all the railway dividends paid in the United States in 1925 had been allotted to the entire amount of railway stock, the return would have been but 4.35 per cent, which is but little more than the rate allowed on savings bank deposits.

Attention Concentrated on Economies in Operation

Confronted with these financial difficulties and with a virtual impossibility of securing increased rates which would pay the return suggested as reasonable by the regulative commission, the railroads have turned their attention to the development of the greatest possible economies in operation.

In the first place, the average capacity and weight of freight cars is constantly increasing. This means that the railroads are hauling more dead weight per car, and unless there is a corresponding increase in the load carried the result will be an increase of operating expenses without a proportionate increase of revenues. There is no doubt whatever as to the economy of large cars when they can be loaded approximately to capacity; but, on the contrary, if they are not so loaded the greater cost and the greater weight of these cars will be a constant drain upon the earnings of the road. The conditions as to loading may be exemplified by reference to to Table II.

Table II

Year	Average capacity of freight cars (tons)	Average revenue load per loaded freight car (tons)	Revenue load per freight car as a percentage of the average car capacity
1903	29.4	17.60	59.9
1913	38.3	21.12	55.1
1918	41.6	26.90	64.7
1923	43.8	25.18	57.5
1925	44.8	24.55	54.8

From this it is evident that from 1903 to 1913 a smaller percentage of the car capacity was filled with paying freight; but during the war, when heavier loading was encouraged so as to utilize equipment to the fullest extent, the average load occupied a considerably larger proportion of the car capacity. Since that time the proportion of the car capacity which is filled with the paying load has again declined until in 1925 it was below what it was in 1903. The results in 1918 showed that no interest was injured by the heavier loading of the cars and there seems to be no good reason why that policy should not have been continued. The average loading of 1925 was 9.9 per cent less than that of 1918. If the loading in 1925 had maintained the standard of 1918 the average revenue load of 1925 would have been 24.55 tons + 10 per cent (approximately) of 44.8 tons, that is, instead of 24.55 tons it would have been 29.03 tons. The extra 4½ tons could be carried with little, if any, increase in the operating expenses and the additional revenue receivd from such heavier loading would have been in the aggregate very large. It would have been a great financial assistance to the carriers, while the shippers would not have been burdened or hampered in their business.

Heavier Car Loading an Important Factor

The most important single means of increasing the efficiency and economy of railway operation is through the heavier loading of cars, so that the amount of the load may correspond more nearly with the car capacity. By this means the three large classes of expense, namely, those for transportation, maintenance of way and structures and maintenance of equipment, may be reduced per unit, when the larger amount of the load can be carried for the same or a slight increase of expense and thereby the operating cost may be borne by a larger paying load. In the last six years, since the railroads of the United States were handed back to their owners, great progress has been made in reducing operating expenses. This progress would have been much greater if the average loading had been maintained at the war level.

In 1926 the average load per car for all commodities was 27.4 tons. If this average load per car had been increased by one ton, the same transportation service could have been effected by 80,000 fewer cars, which, at an average cost of say $2,000, would have represented a saving in railway capital investment of $160,000,000. This economy of capital to the railway companies would be accompanied by corresponding possibilities of economy to the users of the service, for with the heavier loading there would be lower unitary expenses of rendering the service and this would make it possible for the carriers to lower their rates.

But how is this heavier loading of cars to be obtained? It will be evident at once that while many commodities cannot be loaded into cars to the maximum load limit, many others can be loaded to this limit and sometimes beyond it. In order to attain this end there must be co-operation between the shipper and receiver of freight and the carrier. It is necessary to create an intelligent interest in this matter among all those connected with the service and to elicit a better understanding of what an increased or decreased load produces in the way of decreased or increased operating costs and car efficiency. The facts concerning these matters must be kept constantly before the shippnig public and the railroad employees. Shippers must be made to realize that, by more complete loading of cars, they have it in their own power to secure cheaper and more adequate service.

The railroad employees should also be instructed and encouraged to contribute toward this end, for they are responsible for the loading of most of the less than carload freight. This loading process is entrusted in too many instances to men who are in the lowest ranks of railway labor and who have never been shown how to load small shipments so as to use most effectively the car space and to prevent damage to the goods.

Greater Utilization of Terminals and Equipment Needed

Another of the large problems with which the railroads are confronted is the greater utilization of their equipment, terminals, etc. In most cases the terminals are situated in those sections of the city where land is of the highest value because of its intensive use and demand. Consequently, they are subject to a heavy burden of fixed charges on their capital cost and a correspondingly heavy tax imposition. It is essential, therefore, that traffic should be moved as rapidly as possible through the terminals, for while it is standing on the yard tracks it is not earning any revenue for the railway company. The same thing may be said for the movement along the line; the more rapid the transportation the more fully are the roadway and rolling stock being employed in producing revenues, but the longer the cars are standing on sidings and at way stations the less revenue they are producing. Moreover, why should obsolete cars and locomotives be allowed to occupy space in the terminal yards and on the road when their costs of obsolescence and repair are greater than the revenue they yield?

The increasing speed with which freight cars are being moved

is shown by the fact that the number of miles per freight car per day increased from an average of 25.7 miles in 1921-1925 to 28.5 in 1925 and 30.4 miles in 1926. These figures, taken in connection with the fact that the number of ton-miles per car day increased from an average of 457 in the five years, 1921-1925, to 495 in 1925 and 532 in 1926, represent a very decided advance in the utilization of freight cars.

A similar improvement is noted in locomotive performance, for the number of locomotive-miles per freight locomotive day increased from 55.1 as the average for 1921-1925, to 58.3 in 1925 and 61.8 in 1926. Then, too, the numbers of unserviceable freight cars, which in 1921 were 13.1 per cent of the total, were reduced to 6.5 per cent in 1926, and the numbers of unserviceable locomotives, which in 1921 were 23.7 per cent of the total, were reduced to 16.4 per cent in 1926.

The question of depreciation and obsolescence is one which should engage attention. Indeed, this issue has been forced to the front by the recent decision of the Interstate Commerce Commission concerning depreciation. Out-of-date equipment takes up valuable accommodation on the railway tracks and the expense for repairs which is frequently as much as, if not more than, for the better modern equipment. The time spent under repair should be so short that the cars may be kept in service a large proportion of the time, so that, with intensive use, they may render the greatest service in the way of ton-miles per day and per year. The same thing may be said regarding locomotives.

In this intensive use of equipment, it is desirable to concentrate the load into larger and larger units. By increasing the trainload, or the number of tons per train, the large train can be handled with but a slight increase of expense over the smaller train, and the large proportion of constant operating expenses can be divided over a larger paying load, so that the unitary expense is reduced correspondingly. Short haul and predominantly less than carload traffic cannot be concentrated into heavy trainloads; but for the sake of economy all railroads are alert to combine their traffic in this way into larger movable units.

Capital, Wisely Invested, Yields a Surplus Return

The last subject which we wish to consider here is that of capital expenditures in plant and equipment. In Table I we have shown that the increase of capital investment in roadway and equipment exceeds that of nearly every other factor, and at first we are surprised to find this. It would seem that, while operating expenses were keeping well ahead of gross operating earnings and much in advance of net operating earnings, the railway policy would have been to restrict its investment in these forms of capital. In the case of a manufacturing establishment, if operating expenses were proportionately greater than operating income, this would not be a suitable time for enlargement of plant and expansion of operations. But in the case of a railroad the conditions are entirely different fundamentally from those that are found in a manufacturing establishment.

It is found that as the railway expends judiciously upon its line in eliminating gradients and curves and in securing a more substantial and better ballasted roadway, its operating expenses are correspondingly decreased. The same result accrues from improvement of terminals, by means of which the cost of handling traffic through the terminals is reduced and the acceleration of traffic movement is promoted. So, too, in the case of rolling stock: the most improved types of engines, with greater tractive force and less fuel consumption, and the larger and more substantial cars, with their greater carrying capacity and lower proportionate tare, are improvements which contribute very decidedly to economical operation.

Since the railway company has very little control over its rates, from which its revenues are obtained, and since more than half of its operating expenses are practically beyond its control, it is natural that the company should use every appropriate means within its reach to reduce that part of the operating expenses which is under its control. And this, as we have noted above, is effected to the greatest extent through heavy capital expenditures for roadway and equipment. Capital investments, when made with discretion, will usually yield a surplus return over and above the cost of the capital and this is an additional inducement. Besides, there is the fact mentioned a little earlier that these large capital expenditures are necessary in order to make provision for the inevitable increase of future traffic in a growing country and for the possibilities of an emergency rush of business which may come on very short notice. Even although these large increases of capital receive but a low net return, yet they must be made, for reasons just mentioned.

The relative amounts of these expenditures for equipment and for roadway and structures is interesting, as shown in Table III.

The figures for 1926 are as close an estimate as we can get at the present time. For a few years previous to 1923 the amount spent for equipment was much greater than that spent for way and structures, but from 1923 onward the tendency has been to increase the percentage of the total capital expenditures which are devoted to roadway and structures, that is, to those facilities which further the more intensive use of the equipment,

Table III

Year	Total capital expenditures	Expenditures for equipment	Per cent of total	Expenditures for roadway and structures	Per cent of total
1922	$429,272,836	$245,508,801	57	$183,764,035	43
1923	1,059,149,426	681,723,991	64	377,425,435	36
1924	874,743,228	493,608,460	56	381,134,768	44
1925	748,191,000	338,114,000	45	410,077,000	55
1926	875,000,000	380,000,000	43	495,000,000	57

and a smaller percentage to the equipment itself. This tendency indicates a return to the more normal pre-war conditions, when approximately one-third of the capital expenditures were for equipment and two-thirds for fixed plant.

Finally, notwithstanding the well-merited emphasis upon the physical factors of railway operation, the personal and human element is of much greater importance. Without the co-operation of an interested, intelligent and faithful body of employees with an equally intelligent and human management, the whole organization would be as hard and unresponsive as the rails upon which the traffic move. In the words of the late President Smith, of the New York Central System, "Ninety-five per cent of this railroad business is human; the rest is largely steel and coal."

The Status of the Oil-Engine Locomotive

By Alphonse I. Lipetz,

Consulting Engineer, American Locomotive Company, Schenectady, N. Y.

A. I. Lipetz

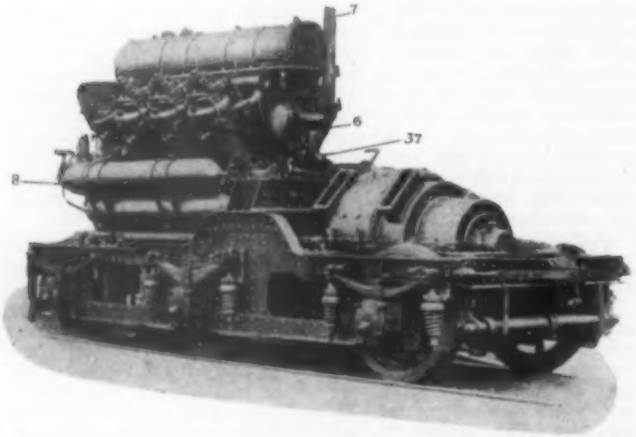
We have at present an established type of Diesel switching locomotives in the United States with electric transmission of 300-600 b.hp. capacity, several switching and suburban locomotives in Germany with hydraulic transmission of 120-400 b.hp. output and four main line locomotives in Russia and Germany of about 1000 b.hp. with electric, pneumatic and mechanical transmissions. In addition to that we shall soon have in this country several main-line locomotives with electric and mechanical transmissions of 750 to 1,300 b.hp. capacity, and in England a direct-driven main-line locomotive of approximately 1000 b.hp. Experience gained from the performance of these locomotives will, undoubtedly, shape the future development of the Diesel locomotive.

So far our experience has been very limited. Some study has been given to, and a certain development work has been accomplished with, the transmission of power on oil-engine locomotives, probably for the reason that this is the most difficult side of the problem. The next side of it, the Diesel engine itself, only now begins to get its due attention. The three other sides—the cooler, the mechanical parts (or chassis), and the auxiliaries, have not yet been sufficiently studied for the reason that they do not offer great difficulties and that any design of the existing automobile radiators, steam and electric locomotive mechanical parts and auxiliaries, properly modified to suit the new conditions, is at least operative.

The type of the oil engine depends upon the system of transmission. If the locomotive driving wheels are not rigidly connected to the Diesel engine and their speed is made independent of the rotation of the oil engine by interposing some variable speed transmission, the oil engine may not differ substantially

from the conventional Diesel engine. A constant speed oil engine can be used, and the variation of its output can be obtained by varying the mean effective pressure. The transmission will provide for the proper resolution of power into variable speed and tractive force of the locomotive. If, however, the locomotive driving wheels should be rigidly connected to the crank shaft of the oil engine, and the speed of the driving wheels thus made dependent upon that of the crank shaft, a different oil engine ought to be used. It must permit a variation in torque and speed within wide limits, just as is being done at present in the engine of the steam locomotive.

Consequently, two different types of oil engines must be considered—one for oil-engine locomotives with variable speed transmissions, and another for direct-driven oil-engine locomotives.



Front Truck Used on the 200-hp. Motor Rail Car Operated by the Saxon Railways

Oil-Engines for Transmission Locomotives

The ordinary oil engine must be modified somewhat in order to be made applicable to a locomotive. The first thing to be taken into consideration is the weight of the oil-engine. The weights of the ordinary Diesel engines vary between 120 and 350 lb. per horsepower. As the weight of the present day steam locomotive amounts per horse-power to only 150-160 lb., it can be readily seen that a heavy-weight Diesel engine, which constitutes only a part of the oil-engine locomotive, cannot be applied to locomotives. Only high-speed light-weight Diesel engines can come under consideration and the present practice is to build engines weighing between 35 and 60 lb. per horsepower. Lighter engines have been used so far on rail-cars, and, if developed into large units, may later be used also on locomotives.

In order to obtain a light-weight Diesel engine, it is necessary to raise the speed to the highest limit compatible with reliable service and reasonable maintenance cost. The high speed of the oil engine not only causes a decrease in the weight of the oil engine itself, but it also affects the design of the transmission, or at least some parts of the latter, and results in a lighter weight of the locomotive as a whole. The present practice is to make Diesel engines running from 350 to about 700 r.p.m., depending upon the size and type of the engine used.

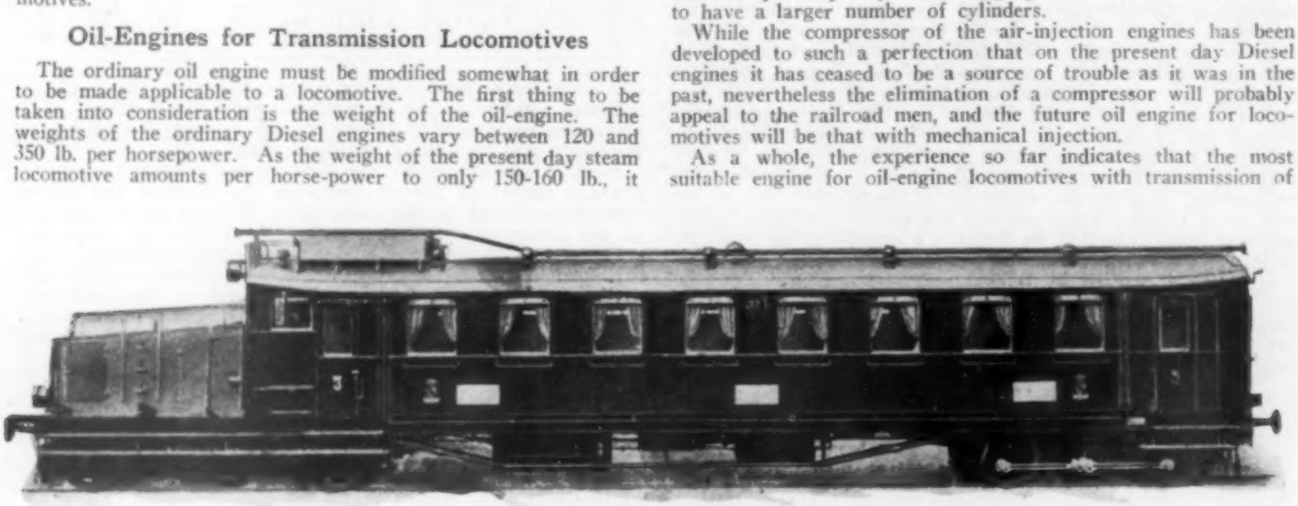
The second question which comes up in connection with the oil engine is the type of it—four-cycle or two-cycle, with air-injection or with mechanical-injection, single-acting or double-acting. While the two-cycle engine has many attractive features, it has not yet become possible to develop a reliable high-speed two-cycle engine. A speed of 400 r.p.m. seems to be the limit for a medium size two-cycle engine, and very few two-cycle engines are successfully running even at that speed. As the mean effective pressure is higher in the four-cycle engine by approximately 50 per cent, and as the speed can be raised to above that of the two-cycle engine by about the same amount, the four-cycle engine predominates in the present oil-engine locomotives, as it gives lighter weights per horsepower and occupies no more space than a corresponding two-cycle would. However, there is no reason why two-cycle engines should not be developed for locomotives, especially as the power of locomotives increases.

The double-acting principle does not seem to be applicable to locomotives as long as the Diesel engine occupies a longitudinal vertical position which, so far, has been the most natural thing to do on locomotives with transmission. The space in the cab does not permit the use of a high double-acting engine. Nevertheless, designs of double-acting or opposed-piston engines for locomotives, of 600-1,200 hp. capacity have been made which seem to be worth trying, as the weight of the engine could be reduced considerably in these instances.

With respect to the system of fuel injection, both systems—air-blast and mechanical—have been used. The progress made thus far depends upon the trend of development of this particular feature of the Diesel engine in general. The mechanical injection is now being favored both in this country and abroad, and the use of it on locomotives will, undoubtedly, progress, depending upon the development of reliable high-power and high-speed mechanical-injection engines. So far, engines with 125 b.hp. per cylinder running at a speed of 500 r.p.m. and with 100 b.hp. per cylinder at 700 r.p.m. have been developed for locomotive use, although in marine practice power up to 300 b.hp. per cylinder has been obtained. The highest power per cylinder of a Diesel engine used so far in a locomotive is with air injection, amounting to 175 b.hp. at 400 r.p.m., and requiring piston cooling. It is doubtful whether piston cooling will be found practicable on locomotives, and this fact will probably limit the power per cylinder. High-power locomotives will have to have a larger number of cylinders.

While the compressor of the air-injection engines has been developed to such a perfection that on the present day Diesel engines it has ceased to be a source of trouble as it was in the past, nevertheless the elimination of a compressor will probably appeal to the railroad men, and the future oil engine for locomotives will be that with mechanical injection.

As a whole, the experience so far indicates that the most suitable engine for oil-engine locomotives with transmission of power is the four-cycle, single-acting, solid-injection, high-speed oil engine.



Saxon Railway 200-hp. Motor-Rail Car Equipped with a Modified Ward-Leonard Transmission System

As regards fuel consumption all good oil engines give more or less the same results. The air-injection engine may sometimes produce a better combustion and have a clearer exhaust in a wider range of power and speed, but this advantage is usually offset by the lower mechanical efficiency due to the loss of power in driving the compressor. As a rule all four-cycle high-speed engines of the above mentioned types, either with air-injection or solid-injection, show a fuel consumption per b.hp. hour of 0.4 to 0.44 lb. of fuel oil of 18,000 B.t.u. heat value at full load and normal speed—this corresponding to an overall thermal efficiency of from 32 to 34 per cent. Two-cycle engines give a slightly higher fuel consumption.

Power Transmission

Owing to the inflexibility of the Diesel engine, the most natural thing to do is to use some sort of flexible power transmission

in which a new intermediate energy is generated (electricity, hydraulic pressure, etc.) and immediately expended, thus permitting a variation of torque and sped at will. Such a system requires, in addition to the full power oil engine, two more full-power machines—a generator, pump, or compressor, as the case may be, and a corresponding electric, hydraulic or pneumatic motor. Assuming that a direct transmission of power by mechanical means is not possible, the full-energy power transmission seems to be the only feasible solution. However, in speaking of the inflexibility of the oil engine, we must not forget that the latter is not absolutely, but only relatively inflexible, and that it can be regulated within certain limits—about 15 per cent above normal and about 75 per cent below normal Consequently, there would be a certain range within which a direct mechanical transmission of power would seem possible. Therefore there is a certain class of power transmissions, known as "differential transmissions," in which the power is transmitted partly mechanically and partly through an auxiliary medium (electricity, oil, etc.); these transmissions have the advantage of using smaller generators and motors and of giving higher efficiencies within the range where mechanical transmission of power is mostly used.

Attempts have been also made to make use of direct mechanical transmissions. While such attempts have not yet passed the stage of preliminary trials, they merit the most serious consideration as they may lead to very desirable and promising solutions.

The electric transmission is, of course, the most orthodox, the most thoroughly studied, the best worked out in all details and the readiest to use. The idea is not new, as all component parts have been known long ago and have proved separately their reliability during many years of service. Many designs were worked out by various locomotive and Diesel-engine builders during the period of 1908-1913, but none of them was ever materialized.

The most essential part of the electric transmission is the control, or the way of coupling the generator with the motors, and the system of varying and reversing the speeds. There are three distinctive methods of doing that—first, the Ward-Leonard control, which has been used extensively on ships and which consists of a generator and motors, both of the shunt type, separately excited—most often from the same source. The excitation of the motor fields is always in the same direction; the excitation of the generator, though, is varied in strength by means of a rheostat and, as regards direction, by a reversing switch, so as to suit the speed of the motor and the rotation which is desired. By varying the voltage applied to the armature terminals of a shunt motor having a constant field excitation, the motor speed can be varied in accordance with the variation in the generator excitation, whereas the direction of the motors with constant field excitation depends upon the direction of the current from the generator with variable excitation. Thus by varying the generator fields from full excitation in one direction to full excitation in the opposite direction, the motors rotate from full speed forward to full speed backward.

This system has been, to my knowledge, used on locomotives in only one instance; in the 1000-hp. Baldwin-Knudsen locomotive. In all other cases, both in this country and abroad, a modified Ward-Leonard system has been used, in which the generator is always excited in the same direction, the variation being obtained in strength by resistance, whereas the motors are made of the series type and the rotation of the motors is reversed by reversing the flow of current through their armatures. The direction of the flow of current in the field does not change. This modified system permits the use of series motors which are particularly suitable for traction purposes.

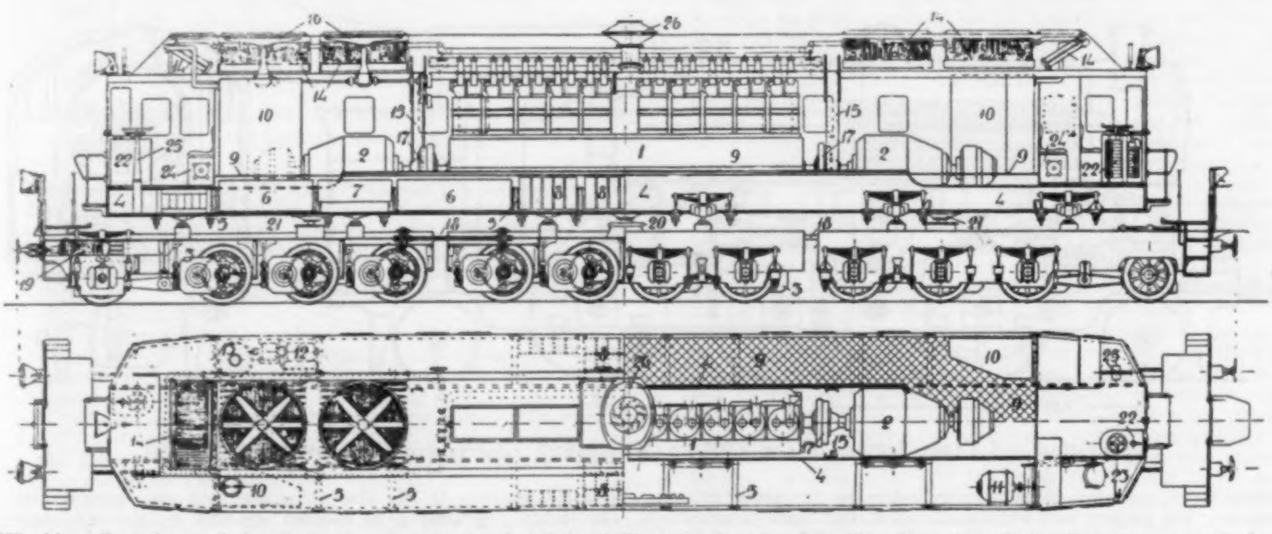
This system has been used extensively abroad and to some extent in this country. It can be found on Diesel railcars built for the Saxon State Railways by Sulzer Brothers of Winterthur, Switzerland, on the Swedish and Swiss railcars and on two 102-ft. articulated cars of the Canadian National, as well as on the 1000-hp Lomonossoff locomotive built in Germany for Russia.

In the two former methods, the control is obtained by inserting resistances in the excitation of the generator. A different type of automatic control developed by Mr. Lemp, formerly of the General Electric Company, is used practically on all Diesel locomotives built in this country, and on seven 60-ft. railcars of the Canadian National. It differs from the modified Ward-Leonard system in that the current from the main generator passes, in addition to the shunt field, through a differential series field, and then through series motors of the locomotive. When the oil engine is running at a certain speed, the field excitation of the generator is modified by the current flowing through the load to suit its own needs. As the load decreases, the flow of current through the differential series field drops and the energizing of the generator field goes up, resulting in higher voltage of the generator corresponding with the higher speed of the motor. Thus the speed of the motors automatically stabilizes in accordance with the load, drawing substantially constant energy within certain limits. The power of the generator is, in this way, automatically resolved into torque and speed to suit the condition of the load. The reversal is obtained in the same way as in the modified Ward-Leonard system by reversing the polarity of the motor-armature or of the field.

The efficiency of the electric transmission varies between 65 and 85 per cent, depending upon the load and the speed. Even higher figures have occasionally been obtained during special tests with a 1000-hp. Russian oil-electric locomotive on a testing plant. The efficiencies of the transmission used in this country are not known exactly, but for calculation purposes it is being taken from characteristic curves of the generator and motors as approximately 75 per cent.

Next comes the hydraulic transmissions, of which the most used is the Lentz transmission or gear, as it is sometimes called, for the reason that it does not change the speed of the driving wheels gradually, but stepwise.

Several other hydraulic transmissions have been brought forth, such as Huwiler, Lauf-Thoma, Hele-Shaw, Naeder, William-Janney and many others, some of which have not yet passed the experimental stage. The latter transmission is also



Working Drawings of the Russian 1,030-hp. Hackel Diesel-Electric Locomotive Showing the Twin Generators and the Arrangement of the Ten Driving Motors on Three Trucks

known in this country as the Waterbury gear, developed by the Universal Engineering Corporation in Montreal.

Quite recently a new hydraulic transmission, system Rosén, was installed in a 300 b.hp. 2-4-2 locomotive built for the Kalmar Railroad in Sweden. The transmission consists of a separate motor and pump connected by means of piston valves which control the amount of working fluid and consequently the speed. The inventor claims an efficiency of about 75 to 85 per cent and the possibility of using the transmission for powers up to 2000 hp.

The difficulty with the hydraulic transmissions seems to lie in the low efficiency resulting from the heating of the oil which, once started, has the tendency to increase in temperature very rapidly. It seems that the presence of air in the oil affects very materially the rise in the temperature, and that some transmissions are more likely to absorb air when running than others. Lentz, for instance, claims that he has entirely overcome this difficulty. This may be due to the low pressures which Lentz employs—about 50 to 150 lb. per sq. in. at full speed and 400 to 500 lb. per sq. in. at starting, while others are applying pressures from 400 to 600, and 1,200 to 1,500 lb. per sq. in., respectively.

The idea of pneumatic transmission is probably one of the first types which occurred to those interested in Diesel-locomotive designs. As far back as 1909, V. A. Stuckenberg, general manager, Tashkent Railroad, Russia, suggested rebuilding steam locomotives in the following way: to replace the tender by a unit carrying a Diesel engine and a compressor, use the boiler as a compressed-air storage tank, and to let the air work in the existing locomotive cylinders in the same way as steam. The project was not considered at that time practicable, and the idea was abandoned. About the same time, James Dunlop, Glasgow, Scotland, came out with a similar proposition.

However, air transmission as suggested by Stuckenberg and Dunlop could hardly offer promising results on account of the low efficiency of air motors and of the cooling effect of air during expansion, which latter would result in lubrication and other difficulties. Schelest, in his book on Diesel locomotives, calculated that the overall efficiency of a Diesel locomotive with air transmission would range between 13.4 and 15.3 per cent. While this is almost twice the efficiency of a steam locomotive, the high first cost of such a locomotive, probably from 3 to 3.5 times that of the steam locomotive, would render the proposition impracticable, and explains why the building of a Diesel locomotive with ordinary air transmission was never seriously attempted.

Nevertheless, the Maschinenfabrik Esslingen, jointly with the M. A. N. Company of Germany, developed a 1,000-hp. Diesel locomotive with air transmission. The design consists of a six-cylinder submarine type M. A. N. engine, referred to above, which drives a compressor. Air compressed to about 110-125 lb. per sq. in., and thus already heated to about 500 deg. F., is further heated by the exhaust gases to approximately 700 degrees F. The engine is now completed and undergoing tests in Germany, so we may soon have data on its performance.

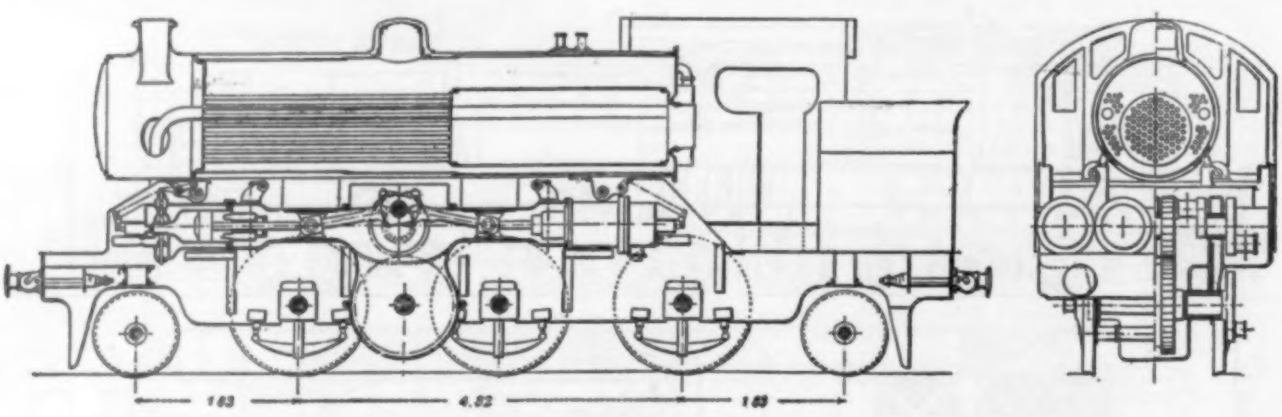
The so-called differential transmissions referred to are very ingenious and numerous but, so far, none of them have been applied to more than railcars and trucks. Only one 500-hp. hydraulic transmission of this class—the Schneider gear—was built, but has not yet been applied to the locomotive for which it was intended.

Gear-clutch transmissions have been in use for a long time in small industrial locomotives and railcars, mostly in France and in Germany, for powers ranging from 30 to 200 hp. They represent a combination of clutches, of a set of gears of the sliding type, of universal joints and bevel gears. Sometimes chains, jack shafts and rods have also been used. The most notable difference in the latest designs of gear-clutch transmissions for cars and locomotives is the replacement of the shifting gear by a series of gears with a corresponding number of clutches, all gears being always in mesh. The friction clutches engage one gear at a time, all other gears remaining disengaged. The change from one speed to another is effected by slipping between parts of the engaged clutch. The clutches are operated manually, pneumatically, hydraulically or magnetically.

The most daring application of a gear transmission has been recently made in 1,000-hp. Diesel locomotive which has been built in the Hohenzollern Locomotive Works at Düsseldorf, Germany. The locomotive has been ordered for main-line service on the Russian Railways in competition with the 1000 hp. oil-engine locomotive with electric transmission. The locomotive is of the 4-10-2 type, has a reversible 1000 b.hp. Diesel engine which acts on a jack shaft by means of three gears always in mesh, with three friction clutches operated magnetically.

Description of Oil-Engine Locomotives

We shall now describe several completed oil-engine locomotives and railcars with Diesel engines. A Swedish Diesel-electric car equipped with a 300 b.hp. oil engine, actually serves as a locomotive. It has also a baggage and mail compartment. The electric generator is coupled directly to the oil engine and is of the eight-pole shunt-wound type, provided with a separate series winding which is used for starting the oil engine by driving the generator as a motor from a storage battery for about from one to one and a half seconds. The speed control is obtained by varying the excitation through a controller on either end of the locomotive.



Elevation and Cross Section of the 1,000-hp. Kitson-Still Locomotive (Dimensions in Meters)

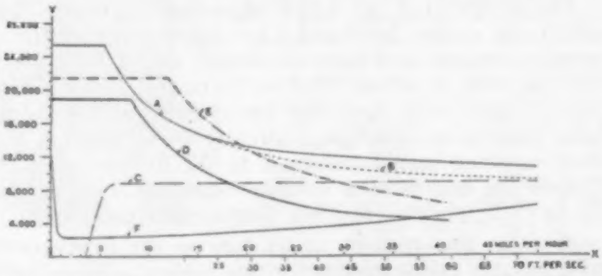
The fuel consumption is between 2.0 and 3.5 lb. of oil per 100 gross ton-miles. According to reliable information from two Swedish railroad companies, this represents an economy in money of 50 to 60 per cent as compared with coal-steam operation. The cost of maintenance of the machinery is very low. For the oldest motor car, which has been in service since August, 1913, the total maintenance cost amounts to 2.16 cents per car mile. At present there are in Sweden in operation altogether 14 cars of this type on some eight small railroads. A complete report of their performance was published by M. R. Jourdin, general manager of the French South-Eastern Railway, after a visit to Sweden in September, 1922. His figures are in conformity with those given above, as are also the results obtained from one of the latest locomotives, delivered in 1924 to the Railway Company of Tunis.

Soon after the appearance of the Swedish motor cars, several Diesel-electric motor cars were built for the Saxon and Prussian Railways by Sulzer Brothers in Winterthur, Switzerland, jointly with Brown, Boveri & Company in Mannheim, Germany. Tests made with the car on the Saxon Railways showed a fuel-oil consumption of 2.92 lb. per car-mile, or 3.86 lb. per 100 ton-miles.

One of these cars was rebuilt into a Swiss railcar with a solid-injection oil engine and electric transmission of the modified Ward-Leonard type. The Sulzer Brothers tests have shown a fuel consumption of 0.446 lb. of oil per b.hp. hour.

They estimate the total efficiency of the electric transmission (generator and motors), together with the mechanical transmission (rods, pins and axles) at 72 per cent, corresponding to a total consumption of oil of 0.62 lb. per rail hp.-hr. They further claim that the consumption of oil per 100 ton-miles is equal to 1.9-3.2 lb. (these figures are very close to those given above by the Swedish railroads), and that this corresponds to only one-fourth of that on regular steam locomotives in Swiss suburban traffic.

The 2-10-2 1,000-hp. Diesel-electric locomotive built in Germany for Russia, known as the Lomonossoff locomotive, is equipped with the 1,000-b.hp. M. A. N. engine. It was first tested on a stationary locomotive testing plant in Germany, and later sent to Russia for regular service. At the testing plant it ran under variable load at variable speeds, each variable being constant, however, during a certain continuous run. The average loads during a series of three trials lasting from 55 to 94 min. were 467, 845 and 876 hp.; the corresponding tractive force was 9,540, 20,400 and 33,600 lb. The consumption of fuel oil per one rail hp.-hr. amounted to 0.537, 0.525 and 0.558 lb., the



Estimated Indicated Tractive Force Curves of the Kitson-Still Locomotive

later figure including the oil for driving the cooling fans. The over-all thermal efficiencies, including all auxiliaries and losses, obtained from numerous tests in addition to the three above mentioned, ranged between 18 and 24 per cent. The efficiency of the electric transmission itself fluctuated normally between 73 and 85 per cent, although occasionally efficiencies of 93 per cent were recorded.

Elaborate comparative tests were made on the same testing plant with an 0-10-0 superheated steam locomotive. At three different tests with loads, speeds and tractive forces, approximately the same as those during the three trials with the Diesel-electric locomotive, the fuel consumption figures were 1.87, 1.64 and 1.86 lb. per rail hp.-hr. of the fuel oil used in the Diesel engine, or over three times as much as those of the Diesel-electric locomotive.

The locomotive has now been in main-line freight service for over two years and has proved to be very reliable. However, some troubles resulting from overheating of electric motors on long grades were experienced. The motors are likely to get hot at high tractive forces and speeds below 20 m.p.h., whereas the air cooling of the motors is more effective at speeds over 20 m.p.h. The locomotive cannot be used continuously at full power at speeds less than 10 m.p.h. In some instances, on very long grades, the speed had to be raised and the tonnage corespondingly reduced. Some difficulties were experienced with electric motor dust strainers, which had been very easily clogged up with sand and oil, thus interfering with proper air ventilation of the motors. On several occasions it resulted in considerable damage caused by loosening of the retaining rings of the motors.

It was found during special trips made from Moscow to the Caucasus, both with the oil-electric and steam locomotives of the same power, that the oil-electric locomotive consumed per each ton-mile 22.2 to 25.0 per cent of the amount of oil burned on a coresponding steam locomotive, thus showing a saving of 77.8 to 75 per cent. The first figures refer to cold weather, when the oil-electric locomotive requires less fuel for the water cooler and can haul heavier trains on account of better cooling of electric motors, and the latter figures to warm weather, when the steam locomotive radiates less heat.

On the basis of obtained information the operation cost per ton-mile in Russia, including depreciation, is estimated to be 18.0 to 25.8 per cent in favor of the oil-electric locomotive. This checks up very well with the actual operation-expense sheet for the first few months after the locomotive was placed in service, and with the above mentioned figures for the American oil-electric locomotives, if the locomotives are fully utilized.

A 2-6-8-6-2 type oil-electric locomotive has been built at the Putiloff Works, Petrograd, Russia, which is known as the Hackel locomotive. The oil engine is a ten-cylinder, solid-injection Vickers engine, developing 1030 b.h.p. at 395 r.p.m. It drives two generators rated at a maximum of 380 volts and 1,500 amperes. The two generators can be connected in parallel for a combined delivery of 3,000 amperes maximum. The locomotive has ten driving axles with motors geared to each axle.

The axles are distributed between three trucks supporting the frame and the superstructure. The trucks are interarticulated by rigid drawbars through which the pull is transmitted without affecting the body of the locomotive. Two vertical fans deliver the cooling air to the radiators. The locomotive has recently been placed in service but very little is known about it. Special tests made with the locomotive showed small fuel consumption —about 24 per cent of that of the ordinary steam locomotive.

Locomotives with Direct Drive

The great success of the steam locomotive must, to a very large extent, be attributed to George Stephenson's fortunate idea of a direct connection between the steam pistons and wheels. It is, therefore, quite natural that present-day Diesel-locomotive designers are striving to preserve the simplicity of the direct-driven steam locomotive for the oil-engine locomotive. In order to do that they have had to solve the problem of starting and, to a certain extent, that of speed variation. This has not yet been satisfactorily done, but very interesting attempts in this direction have already been made.

The Borsig-Sulzer locomotive was the first attempt of this kind. It had a direct connection between the Diesel-engine crank shaft and the driving wheels by means of side rods. Dr. Diesel himself was the designer of the locomotive, but he did not seem to be fully cognizant of the inflexibility of the Diesel engine and its poor adaptability to locomotives. He tried to solve the problem by using compressed air for starting the locomotive with the train. The engine had to be run with compressed air until the speed of the locomotive and train reached the ignition speed, which for this particular locomotive was 6.6 m.p.h. In order to supply enough starting and accelerating power a separate compressed air outfit had to be provided. The locomotive was, therefore, equipped with two Diesel engines—a main engine and an auxiliary engine. The main engine was a four-cylinder V-type single-acting two-cycle engine of 1000 m.p.h. at 304 r.p.m. The auxiliary engine was a vertical two-cylinder two-cycle engine of 250 h.p., cylinders 12 in. by 15 in., connected with a horizontal multi-stage compressor; the object of this engine was to generate air for starting, supercharging and other purposes.

Starting by air, however, did not give satisfactory results. In order to obtain good efficiencies it was necessary to apply high rates of expansion, which resulted in low temperatures at the end of expansion and cooled the cylinders to such an extent that ignition became impossible. Short expansions, on the other hand, resulted in very low efficiencies and consequently in high consumptions of air which the auxiliary engine was unable to supply. In addition to this, the crank shaft broke at the end of 1913 and was replaced in spring, 1914, and some other parts also proved to be defective. The locomotive was all the time undergoing repairs and changes; nevertheless, several satisfactory runs were made and valuable experimental data were collected but the work was abruptly stopped at the beginning of the world war. During the war the locomotive was scrapped.

Two designs of direct-driven locomotives of considerable size, embodying the Still principles of starting, have recently been worked out in detail, and at least one locomotive is at present under construction in Leeds, England, at the plant of Messrs. Kitson & Company. Another was to be built in France at the works of Schneider & Company in Creusot, but for some reason the work has been temporarily postponed. The Still engine is a combination of an oil engine with a steam engine, the steam being generated in a separate boiler by the waste heat of the oil engine, and being expanded in the oil-engine cylinder, on the other side of the piston. The boiler is placed in communication with the water jackets of the engine cylinders, and thus both the cylinder jacket heat and the exhaust gas heat are utilized for steam generation in the Still engine.

The Still engine, in addition to its low fuel consumption, offers a very good combination for train starting, steam being an ideal fluid for this purpose. Of course, if the engine has not been run before starting, it becomes necessary to heat the boiler with a specially provided oil burner in order to generate steam for starting. However, in so doing the cylinders are warmed up, ignition is facilitated and starting on oil is rendered much easier. The presence of a boiler on an oil-engine locomotive may prove to be of great value, as it offers a large amount of stored and available energy, especially with the oil burner in operation, which can be utilized on heavy grades and in emergencies, even though at the sacrifice of fuel economy. There are, of course, disadvantages to the system.

The Kitson-Still locomotive is shown in one of the illustra-

tions. The oil engine is of the four-cycle type, and has eight horizontal cylinders driving a four-crank shaft placed underneath the boiler and geared to a jack shaft. The boiler is of the locomotive type with a modified fire box. The outside cylinder ends are those of the oil engine; the inside ends are those of the steam engine. The cylinders are 13½ in. in diameter by 15 in. stroke. At 450 r.p.m., which corresponds to a locomotive speed of 45 m.p.h., the crank shaft horse-power is about 880 on internal combustion sides, and about 1000 on both combustion and steam sides. Rail tractive force at this speed is 7,000 lb.

Starting takes place through the action of steam on the inside surfaces of all eight pistons. The starting tractive effort is 25,450 lb. at boiler pressure of 200 lb. per sq. in. The estimated weight of the locomotive is 156,800 lb., that is, 157 lb. per horsepower at maximum speed, or almost the same as in ordinary steam locomotives. The wheel arrangement is 2-6-2; the weight on drivers is 114,240 lb.; the adhesion factor is thus 4.5. The locomotive is almost completed and test results should be known this year.

The Still locomotive represents a radical departure from previous oil-engine locomotives. A locomotive with a constant power prime mover and a transmission of the kind described above has a hyperbolic speed-tractive force characteristic, which drops very rapidly with the increase in speed. The locomotives with direct drive as the Borsig-Sulzer, if at all possible, give a straight line (constant torque) characteristic with slight increase at low speeds. The steam locomotive speed-tractive force curve lies somewhere between the hyperbola and straight line, and the Still locomotive's curve comes closer to the steam line than that of any other oil-engine locomotive. The estimated indicated tractive-force curves of the Kitson-Still locomotives in comparison with various steam locomotives are shown in one of the charts. Curve A corresponds to the Kitson-Still locomotive with boiler at full service (burners turned on); curve B to same with burners gradually cut out; curve D to a steam locomotive with 18-in. by 24-in. cylinders and 58 in. drivers; curve E to a steam locomotive with 20-in. by 26-in. cylinders and 68-in. drivers. Curve C gives the tractive force of the Kitson-Still locomotive obtained from internal combustion ends only.

Curves A and B, it can be seen, have the characteristic appearance of steam locomotive tractive-effort curves. This is, of course, a great advantage of the Still system, resulting, as many other advantages, from the fact that the Still locomotive is a combination of an oil engine with a steam engine. This combination, however, especially in a locomotive, also has its disadvantages; for instance, the realization of tractive-forces beyond certain limits will require the application of the oil burner and will cause a loss in thermal efficiency. The boiler will then be subject to wear, accumulation of scale, stand-by losses, maintenance repairs, although to a lesser degree than in ordinary steam locomotives, but, nevertheless, to an extent depending upon the length of time during which curve A is used instead of B. If steam is very often used at low speeds on heavy grades it may impose on the boiler a great amount of work and result in an appreciable increase in fuel consumption and cost of maintenance. The necessity of using oil for the burner, in order to be able to control the fire easily, may not be favored in places where coal is cheap. On the other hand, on level roads, with uniform conditions of traffic, the Still locomotive, especially with passenger through trains, may run for long periods of time on oil with very little steam, and that probably steam which is being generated by waste heat from the oil-engine exhaust. A great advantage of the Still locomotive is the elimination of cooling arrangements.

When the Kitson-Still locomotive is placed in service, presumably this coming fall, it will be an event of the greatest importance for the oil-engine locomotive development. The doubtful points about the advantages and disadvantages of the Still system will be cleared up as soon as test results are available, and the locomotive will be watched with keen interest by locomotive and railroad men.

Discussion

Dr. W. F. M. Goss: This paper is impressive as to the progress which the world is making in the development of transportation along lines more or less parallel with the progress of the last 100 years in the development of the steam locomotive, and those of us who have been fond, perhaps more than fond of the steam locomotive, and who still feel a strong affection for it, begin to be conscious of the fact that the rivals of the steam locomotive are making inroads on her field. This is not to be regretted. This is progress. The extent to which this progress is developing is a wonderful compliment to the energies and to the ability of the designing engineers of this and other countries. I can't refrain from calling attention to the fact that we all need to be on our mettle to see that the steam locomotive is not entirely left out of the running.

Mr. Fetters: The development of the Diesel locomotive appears to embrace two fundamental problems: The development of a suitable prime mover and, it being necessarily a constant speed or nearly constant speed engine, the development of ways and means for converting that energy at constant speed into the necessary varying torque required by the variable speed of the vehicle.

The former problem is undoubtedly well under way, and a great many types of Diesel engines are now being developed suitable for small powered locomotives.

The weight per hp. is an important problem. The old Diesel engine developed a horsepower for 100 lb. of weight or more, and naturally would not be very useful for this new problem. But in Germany I saw Diesel engines that were operating successfully at 4.4 lb. per hp. They were developing aircraft Diesel engines that they expected would reduce it to 2.2 lb. per hp. The Beardmore engine is a notable example, being around 11 to 13 lb. per hp., and is a successful type.

A great deal remains to be done in the development of a suitable prime mover, for this reason: At the present time, for the present size of engines, the clearance diagram limitations will not permit building oil engine locomotives in the sizes required in this country. If you lay down one of the latest successful 1,000 hp. Diesel engines on your vehicle, and see where it comes on your clearance, you will be surprised, because it just about takes up all of the room that the American clearances now permit.

As to the transportation problem, it is even more serious. Mr. Lipetz explained the many proposals of transmitting the power of the engine to the rails, including the mechanical, hydraulic, electric, compressed air, compressed steam, and compressed exhaust gases. They all have potential possibilities, but I was much surprised when in Europe last fall to find that the Germans, particularly, seem to think that the electric transmission is not the ultimate solution of the problem on account of its extreme weight and extreme cost.

But in looking over some of the proposals they had as a substitute for electric transmission, such as the Schneider hydraulic transmission, and the Krupp clutch drive. I concluded that the electric transmission was far out in the field. It is notable that in our country nearly all of the units so far proposed and built have been on the basis of the electric transmission. Ultimately, the electric transmission will win out on account of its great flexibility, its fair ratio of conversion of power, and the fact that we all thoroughly understand it and know how to take care of it.

I think Mr. Lipetz's paper is a wonderful paper.

Professor A. J. Wood (Penna. State College): We sometimes forget that in the development of a new line of power there are a great many steps that lead up to the final completed machine.

The subject of gas engines is new compared to the subject of steam engines. We must not forget the fact that the gas engine itself, independently now of its special application to rolling stock, is in the state of flux. We cannot say at the present time that the gas engine is as complete a development as the steam engine, taken as a whole.

At the present time there are many radical and impor-

tant developments on the way in the development of the oil engine. Until the atomization and mixture of the fuel has been developed, we will not have reached the highest efficiency in this type of engine, and, in that we are limited the same as we are in the steam engine to temperature conditions. If we can secure more heat with the same fuel, but not exceeding the limits of temperatures, there is going to be a still greater efficiency of the oil locomotive, and therefore in the comparison of the oil and steam our principal measure is a measure of temperature rather than of pressure.

It is a limitation, at the present time largely metallurgical, at which we must stop, and the developments which are now going on promise a greater per cent of increase in efficiency of the oil engine as applied to transportation than is possible with steam. Therefore, we must, of necessity, try to produce still greater results in the steam locomotive.

Report on Locomotive and Train Lighting

W. E. Dunham
Chairman

The report on locomotive and car lighting is presented by the committee with the following comment:

"The introduction of the body suspended generator, some years ago, brought with it several important advantages as regards safety, simplicity of generator suspension, truck conditions, method or procedure of applying the axle pulley, facilities for inspection, repairs, etc.

"The committee has kept in touch with the progress of the art in this connection and has found a rather decided trend toward the mounting of the axle pulley, for body suspended generators, at the center of the axle, thereby aligning the belt with the longitudinal center line of the car. This arrangement gives increased security in the application of the pulley to the axle, better facilities for making inspection and repairs and appreciable increased belt life at little or no increase in the cost of application. The tendency appears to be strongly in the direction of a more general or widespread use of this form of application, and because of the advantages accruing, its further use should be encouraged.

Photometry of Headlights

"Experiments have been conducted during the past year or two with a view to developing a more convenient and satisfactory method of photometric measurement of electric headlights to facilitate comparisons between different makes of equipment when purchases are made upon a competitive basis and to enable any railroad readily to check equipment in active service. So far the results of the experiments have not been very encouraging and the experiments are, therefore, being continued.

Axle Generator Specifications

"The specifications for axle generators, outlined in the manual, are in need of general revision. It was found impossible to complete this work for inclusion in this report. The revision is, however, now under way and it is expected that formal report may be made at the 1928 Convention.

Revision of Section H of the Manual

"Section H of the manual is in need of complete revision. The existing text is not well arranged and in a number of instances the meaning is not clear. A general revision has been undertaken and is presented herewith. In preparing this revision, the scope of the work of the committee has been grouped under four general subjects: Locomotive, Car, Motor Coach and Street Railway Lighting.

"The last two subjects have not, so far, been touched upon by this committee, but it is expected that there will be activity in these directions in the future. In the preparation of the revisions, herewith, it was found desirable to treat certain subjects, such as schedule of incandescent lamps, dimensioning of glass reflectors, etc., in more or less minute detail and more or less independently of the code of recommended practices. These subjects are classified as appendices and reference is made to them in the code.

"The revision of Section H, herewith, includes the following items:

(A) Code of recommended practices relating to locomotive lighting.
(B) Code of recommended practices relating to car lighting.
(C) Appendix A. Outlining in detail the existing method of photometry of locomotive headlights. If and when a more satisfactory method is developed, the new method will be offered as a substitute for the existing method.
(D) Appendix B. Dimensioning of reflectors for electric headlights. The method of dimensioning described is such that glass and metal reflectors may be directly compared and the membership is urged to insist that manufacturers list their dimensions, as outlined.
(E) Appendix C. Schedule of incandescent lamps for locomotive, car, motor car and street railway service.

"The revisions, herewith, have been made with a view to simplification and clarity. While the wording of the code has been changed in many instances, no material change has been made in the intent and purpose of the code, except as follows:

"Center Drive for axle generators has been recognized as the preferred form of application. Other forms of drive may and probably will be required in some instances. Such forms of drive are not prohibited in the revised code.

"The voltages for locomotive lamps have been modified by changing cab lamps from 33 volts to 34 volts, and headlight lamps from 32 volts only to 32 volts or 34 volts as desired. These changes are suggested by reason of the fact that some systems of train control employ voltages too high to permit the use of 32-volt lamp.

"It will be noted that no revision of the specifications for axle generators is offered. This is due to the fact that these specifications are now in process of revision. When this work is completed these specifications will be included as Appendix D.

"In view of the above, the committee recommends the withdrawal of all of Section H of the Manual and the substitution therefor of the revised Code of Recommended Practices and Appendices, accompanying this report.

Definition of the Words "Lamp" and "Light"

"Considerable confusion has occurred in the work of this committee through the indiscriminate use of the words 'lamp' and 'light.' The committee has accordingly adopted for its use the definitions noted below and recommends that these definitions be accepted and used by the membership.

"The word 'lamp' shall mean the device, consisting of filament, bulb, base and other parts that is the source of or which generates light.

"The word 'light' shall mean the fixture complete, including the lamp, reflector, housing, etc."

The report proper consists of specifications for locomotive lighting and car lighting. Except for a few minor details all of these specifications have been published previously in the manual of the Association of Railway Electrical Engineers and are therefore not included herewith.

The report includes also three appendices. Appendix A outlines a method of photometering locomotive headlights and consists for the most part of a description of an improved photometer table. Appendix B covering dimensioning of headlight reflectors is included in the manual of the Association of Railway Electrical Engineers. Appendix C follows.

Schedule of Incandescent Lamps

LOCOMOTIVE LIGHTING SERVICE

Watts	Voltages	Bulb	Base	Remarks
15	34	S-14	Medium	Cab
15	34	S-17	Medium	Cab
*60	32 or 34	P-25	Medium	Head light
*100	32 or 34	P-25	Medium	Head light
250	32 or 34	P-25	Medium	Head light
**250	32 or 34	G-30	Medium	Head light

*The 100 watt lamp in inside frosted bulb is now being furnished and it is expected that it will, in the near future, supersede both the 60 watt and the 100 watt clear bulb lamps.

**The 250 watt lamp in G-30 bulb is being superseded by the same lamp in P-25 bulb.

TRAIN LIGHTING SERVICE

Watts	Voltages	Bulb	Base	Remarks
*15	32, 34, or 64	PS-16	Medium	....
*15	32, 34, or 64	G-18½	Medium	....
*25	32, 34, or 64	PS-16	Medium	....

(Continued on page 1876)

(Continued from page 1875)

Watts	Voltage	Bulb	Base	Remarks
*25	32, 34, or 64	G-18½	Medium	....
*50	32, 34, or 64	PS-20	Medium	....
75	32, 34, or 64	PS-22	Medium	....
*100	32, 34, or 64	PS-25	Medium	....

*The following inside frosted lamps are now in regular production. It is expected that they will supersede the above indicated lamps (*) and their use is, therefore, encouraged.

Watts	Voltages	Bulb	Base	Remarks
15	32, 34, or 64	A-17	Medium	....
25	32, 34, or 64	A-19	Medium	....
50	32, 34, or 64	A-21	Medium	....
100	32, 34, or 64	A-23	Medium	....

MOTOR COACH LIGHTING SERVICE

Candle power	Voltages	Bulb	Base	Number	Remarks
3	6-8	G-6	DC-bay	64	Dash
6	6-8	G-8	DC-bay	82	Tail
21	6-8	S-11	DC-bay	1,130	Interior and hd. lt.
21	6-8	S-11	SC-bay	1,129	Interior and hd. lt.
3	12-16	G-6	DC-bay	68	Dash
6	12-16	G-8	DC-bay	90	Tail
21	12-16	S-11	DC-bay	1,142	Interior and hd. lt.
21	12-16	S-11	SC-bay	1,141	Interior and hd. lt.

The 3 and 6 candle power lamps may be used for sign, marker and auxiliary lighting.

STREET RAILWAY LIGHTING SERVICE

Watts	Voltages	Bulb	Base	Remarks
23	105, 110, 115, 120, 125, 130	S-17	Medium	....
36	105, 110, 115, 120, 125, 130	S-19	Medium	....
56	105, 110, 115, 120, 125, 130	S-21	Medium	....
94	105, 110, 115, 120, 125, 130	S-24½	Medium	....
23	105, 110, 115, 120, 125, 130	G-18½	Medium	Head light
36	105, 110, 115, 120, 125, 130	G-18½	Medium	Head light
56	105, 110, 115, 120, 125, 130	P-25	Medium	Head light
94	105, 110, 115, 120, 125, 130	P-25	Medium	Head light

The following gage lamps, 1⅛ in. maximum overall length, are for use in series with headlights.

Amps.	Voltages	Bulb	Base	Remarks
.214	3	T-3	Miniature	(In series with 23-w. hd. lt.)
.342	3	T-3	Miniature	(In series with 36-w. hd. lt.)
.519	3	T-3	Miniature	(In series with 56-w. hd. lt.)
.863	3	T-3	Miniature	(In series with 94-w. hd. lt.)

The lamps listed in this schedule are for use five in series on 525, 550, 575, 600, 625 or 650 volt circuits and should invariably be so ordered.

The report is signed by W. E. Dunham (chairman), Chicago & North Western; J. L. Minick, Pennsylvania; E. Wanamaker, Chicago, Rock Island & Pacific; E. W. Jansen, Illinois Central; A. E. Voigt, Atchison, Topeka & Santa Fe; E. Lunn, The Pullman Company, and H. A. Currie, New York Central.

Discussion

Mr. Tatum: In the committee's report it is noted that no reference is made to voltage regulation. We believe that it is very important that definite limits, both maximum and minimum, should be prescribed for all conditions of load and steam pressures as specified by the committee. We suggest that the voltage be allowed to rise from a normal of 32 to not exceed a maximum of 33½ volts and that a minimum of not less than 30½ volts be permitted. This is a total variation from minimum to maximum of nearly 10 per cent which should be easily met by a first class modern turbo-generator and that this regulation should be maintained by the railroads.

If the voltage is allowed to decline below certain limits unnecessary train stops will result, in train control territory.

The committee apparently has made no effort in conjunction with the manufacturers to determine upon a standard headlight case. We believe it important that this phase of the subject should be developed with a view to the final development of a standard headlight case which, with certain minor variations, would meet all railroad requirements.

We agree with the committee that it is important to limit the number of different sizes of ball bearings, but apparently the committee has not developed this subject with the manufacturers. For example, all of the three leading makes and types of turbo-generators in most cases use bearings other than those specified by the committee. The Keystone type 832 machine is equipped with Nos. 207 and 206 bearings. The Pyle-National MO-6 is equipped with No. 307 bearings. The Pyle-National E-3 is equipped with Nos. 308 and 310 bearings. The Sunbeam R-4 is equipped with No. 306 bearings. Possibly the committee might be able to develop this subject more fully with the manufacturers with a view to finally arriving at an agreement.

Under the heading of classification and marker lights, paragraph (a), it is not clear just what the committee has in mind. Possibly what they intended saying was "If electric classification and marker lights are used they shall be applied as required by the A.R.A. code of train rules." As written it may be implied that electric classification and marker lights shall be applied. In addition, it may have been the committee's thought that so-called white "back-up" lights should not be used. We believe that the committee should re-word this to make its meaning clear.

Under the heading of wiring, the committee recommends the use of metal conduits. Our present standard practice is to use open wiring in the cab for both headlight and train control circuits. Our last 20 Class P locomotives were equipped with metal conduit for all cab wiring. Comparison should be made as time goes on between the cost of maintaining the wiring installation in conduit with that of open wiring.

We are approaching the time when it might be best to segregate the Locomotive Lighting Committee from that of Car Lighting on account of the fact that the locomotive headlighting equipment is the source of energy for train control operation as well as the lighting of the locomotive. As new problems, such as electrical interferences, voltage regulation, must be dealt with, we believe that shortly the problem will have assumed such proportions as to necessitate the appointment of a committee to deal exclusively with the matter of electric energy supply on the locomotive.

A separate committee could be provided to report on electric car lighting which matter is much more nearly standardized and there are fewer problems to solve than is the case with electrical equipment on the locomotive where operated in train control territory. Most of the men now on this committee are those with specialized car lighting experience. The personnel of the committee might, therefore, be revised for next year and their work segregated as above outlined.

Mr. Purcell: The personnel of that committee is such that it is not necessary to increase it and put on locomotive men. The committee will look over the list of its members and if it is felt necessary or advisable it will add probably an electric headlight man.

G. W. Rink (C. R.R. of N. J.): In paragraph (c), it is mentioned that the steel inlet at the turbo-generator shall be of ½ in. iron pipe. The tendency today is to go toward ¾ in. pipe. Has the committee stated any preference as to the location of the generator, whether

"The Toronto," the Second Locomotive in Ontario Built by James Good, Toronto, in 1852-53

on the smoke box or on the fire box head of the cab? Our practice has always been to locate the turbo-generator on the smoke box, but we are now gradually transferring the generator to the other position.

Mr. Dunham: There is absolutely nothing in this report which is new or changed from what we have had right along.

The report was accepted.

Relation of Locomotive Development to the Cost of Operation*

By W. H. Winterrowd
Vice-President, Lima Locomotive Works, Inc.

W. H. Winterrowd

Any consideration of the relationship of the modern locomotive to the volume of business handled and to the direct cost of operation of our railways takes on added significance if prefaced by a brief study of operating statistics. This study develops a number of important facts. It shows that during the past twenty years, with but a slight increase in main trackage, the railways have handled a vastly increased volume of business. Of outstanding significance is the fact that trains steadily increased in weight and moved faster. In other words, the railroads produced more gross ton miles per train hour, an increase which in 1925 amounted to 123 per cent over 1906, and 57½ per cent over 1916.

This remarkable increase in gross ton miles per train hour or power output is due to a number of factors among which may be mentioned grade reduction, improved signalling, improved terminal facilities, larger cars and larger locomotives. The locomotive has played the most important part in this increase. Year by year it has grown in size and capacity. With each increase, heavier trains resulted. This growth in size of motive power continued until a few years ago when property restrictions made further increase impractical.

This, however, was no bar to increased power and economy and locomotives were designed and built that since then have set the pace for still further and more intensive railroad operation. These locomotives without increased weight on driving wheels are capable of greatly increased power output with a remarkable increase in economy of operation.

The table which follows shows the remarkable progress in locomotive development that has taken place since 1921. Here we will see the large increase in horse power output, or the ability to produce more gross ton miles per train hour. The steady increase is impressive, particularly so when we note the greatly increased fuel economy that has accompanied it.

Increase in Horsepower and Decrease in Unit Fuel Consumption, 1921 to 1925

	Cylinder hp.	Lb. coal per d.b.hp.
1921 Mikado	2,300	5.66
1922 modern Mikado	2,766	4.44
A-1—1925	3,675	2.98
Per cent change, 1921 to 1925	59.5 inc.	47.5 dec.

Railroad men and locomotive builders have approached the problem of increasing the usefulness and efficiency of the locomotive from different angles, but all are aiming at the same results—the production of maximum power with the lowest cost of operation. Certain fundamentals of design are now in use by all the builders. These are: high boiler capacity with low combustion rates; high cylinder capacity and economy in use of steam, and refinement of design to increase power capacity and decrease the cost of maintenance.

High boiler capacity with low combustion rates demands a boiler with a large firebox and a large grate area. The first recognition of the value of this combination was evidenced years ago when the narrow firebox between the frames was superseded by the so-called wide firebox. Locomotives continued to grow in size bringing about ever increasing demands upon the boiler and firebox. To meet this growth and provide the necessary boiler capacity, the firebox and grate area were again enlarged. This increase was made possible by the introduction of the two wheel trailer truck to carry the additional weight.

Railroad operation continued to demand more and more power from the locomotive. A point was reached a few years ago when it became impossible to further increase axle loads in order to provide the necessary boiler capacity. Locomotives were being built with grate areas as large as weight limits would allow but these were already being worked at such high rates of combustion, and at the expense of economy, that the limit to further power increase was definitely located in the firebox. The solution of the problem was to again increase the size of the firebox and grate area. Such a locomotive was built with the increased weight carried on an additional trailer axle. This resulted in the four wheel trailer truck.

When the limits of the four wheel trailer truck, firebox and grate area are eventually reached, as they will be, by ever increasing demands of operation or by the requirements of burning low grade fuels, the next step may be a still larger firebox and grate area, the weight of which may be carried by a six wheel trailer truck.

At the present time, there are nearly three hundred locomotives in service or on order, in both freight and passenger service, that are equipped with large fireboxes, the weight of which is carried by four wheel trailer trucks.

[Moving pictures were introduced here to illustrate how low combustion rates produce economical boiler performance, and how large grate area increases boiler capacity, keeping the road working range well within the economical range of boiler efficiency. The pictures showed that for the ordinary Mikado, the normal range of operation includes the sharp drop in efficiency near the point of maximum capacity of the boiler.—Editor].

To produce higher drawbar horsepower output, recent designs of locomotives all take advantage of using steam more expansively coupled with high boiler pressure. Several methods of obtaining this objective include: two-cylinder limited cutoff arrangement with high boiler pressure; three-cylinder simple arrangement, in which limited cutoff is sometimes used; three-cylinder compound arrangement with high boiler pressure, and two-cylinder compound arrangement with high boiler pressure.

The first method, now represented by 145 locomotives in service or building, is to increase the cylinder power by limiting the cutoff and raising the boiler pressure. This has the effect of slightly increasing tractive force at starting and the advantage of raising the drawbar horsepower at operating speeds in proportion to the increase in pressure.

[Moving pictures were here introduced to show how limited cut-off and high boiler pressure accomplish this power increase, without increased weight on drivers, and how marked steam economy is also effected.—Editor.]

It follows that if less steam is required to produce a given amount of work, there will be a reduced demand upon the boiler. The boiler with the large grate area can produce steam more economically than one with a small grate. We thus have the combination of reduced demand upon the boiler and increased efficiency of combustion. Just what this combination means in fuel economy is shown the table.

*Mr. Winterrowd's paper was illustrated with moving pictures and lantern slides. Such information from the pictures as is essential to an understanding of the test has been included in notes or tables.—Editor.

Influence of Low Combustion Rates and Cylinder Economy on Fuel Consumption

	Equial horsepower			Equal coal consumption		
	Hp.	Lb. steam per hour	Lb. dry coal per hour	Coal per hour	Lb. steam per hour	Hp.
A-1	1,600	40,500	4,750	6,000	48,000	2,028
1922 modern Mikado	1,600	47,500	7,100	6,000	42,600	1,352

The use of limited cut off and high boiler pressure results in increased power, which means increased piston thrusts in a cylinder of given size. The distribution of these thrusts within limits that insure nominal stress and cool running pins was solved by what is known as the articulated or extended main rod. This type of rod is now in use on about 200 engines in service or building. This design has the advantage of distributing the piston thrust over two of axles and two pairs of boxes and pins instead of one. The A-1 locomotive has made approximately 85,000 miles in the hardest and most exacting kind of service on a number of railroads. The original brasses are still in her driving boxes. Recent examination indicates the brasses are still in splendid condition and the locomotive is continuing her service with these brasses in place.

One road using the extended type of main rod reports a piston thrust of 165,000 lb. and an average life of 24,000 miles per set of bushings as against 15,000 miles per set on a standard locomotive having the ordinary rod arrangement and a piston thrust of only 123,000 lb. It is easy to see what this means in reduced cost of maintenance.

The use of cast steel cylinders illustrates how reduction in weight makes possible increased boiler capacity. Cast steel cylinders applied to the A-1 locomotive permitted a saving in weight of 4,000 lb. This weight when put back into the boiler produced additional capacity. Cast steel cylinders have the additional advantage of greatly simplifying and reducing the cost of repairs. Should a cylinder become damaged, it is a simple matter to weld cast steel.

There are a number of other factors which make for marked reduction in maintenance and therefore are a factor in reduced operating costs. Automatic wedges insure proper wedge height continuously. This reduces rod, pin and driving box maintenance. Articulated four wheel trailer trucks permit maximum capacity ash pans. This eliminates the necessity of stopping trains to clean pan or reduces the time at water stops where pans would ordinarily be cleaned. The articulated four-wheel trailer truck also has the advantage of transmitting the drawbar pull of the engine closer to the center line of the track. This makes for additional capacity and also reduces the wear on driving wheel tires. Superheater cover boxes permit access to the superheater and smoke box throttle without the expense of opening up and tearing out smoke box plates and netting. Smoke box throttles afford closer control of the engine, which reduces slipping. This results in decreased driving tire wear. Dome shut-off valves make possible repairs to steam pipes and throttles without blowing down the boiler. Large capacity tanks decrease stops for water and permit passing water plugs where water is bad. This reduces the cost of boiler maintenance. Large boilers produce steam without forcing. Maintenance is always less in boilers that are not forced and which are worked in a normal range.

Air compressors located on the front end and accessible from the engine house floor facilitate inspection and insure easier and better maintenance. Piping of all kinds simplified and properly braced. It is also located where it is accessible with minimum labor and expense.

In addition, there are a number of other factors that make for increased capacity and economy. Their use has been so well established that in a presentation of this kind, a mere enumeration of them is sufficient. These include Type E superheaters, feedwater heaters, superheated steam for auxiliaries, syphons, arches and long valve travel.

Relation to Cost of Operation

Locomotives built along the lines illustrated in the preceding scenes have been in operation long enough to show how they will affect operating costs.

One railroad reports a number of modern two-cylinder switch engines in service with high boiler pressure, limited cutoff, feed water heaters, and a tender booster. This road states that not only do these locomotives produce more power and make possible the handling of a greatly increased number of cars but do it with so much economy that the saving in fuel alone will pay for the first cost of the engines in seven years. Is power like that a good investment?

Another road with highly modern switch engines has made a careful study of the cost of operation and states that the modern power has decreased the cost of handling cars 19½ per cent. This includes wages, fuel, locomotive repairs, and engine house expense. Due to improved design, material and workmanship, the maintenance costs on the basis of cars handled have been decreased 40 per cent. Fuel consumption has been decreased 37½ per cent. These savings brought about by the introduction of these modern locomotives have resulted in earnings at the rate of 58.7 per cent on the investment. Is such motive power a good investment? Would you hesitate long to invest money that would safely bring such a return?

In order to give you a picture of what the modern super-power locomotive will do and how it is related to the cost of operation, a detailed study was made upon a particular road, where quite a number of such locomotives are in regular service. I call attention to the fact of many engines in regular service so that the results will not be confused with the performance of any particular individual test.

Relation of Modern Freight Power to Cost of Operation

For a given amount of work on a division 100 miles long

Annual traffic = 2,435,000,000 gross ton-miles
Traffic per day = 82,200 gross tons

	Super power locomotives	Old locomotives
Average train load	1,533	1,148
Trains per day	53.6	71.6
Train miles per day	4,350	5,810
Locomotive miles per locomotive day	4,710	6,450
Number of locomotives daily	42	59
Cost of operation	$2,342,470	$3,107,060
Gross saving	$764,590	....

This date, which is summarized in the table, is the result of intensive study of the railroad's operating figures over a period of three months and covers all factors of freight train operating results and their costs. Comparisons are all made on the basis of actual performance. They show that increased power output and increased economy result in greatly decreased operating costs. The train load increased 33 per cent, the average train speed 7.4 per cent and fuel consumption decreased 18.5 per cent. The cost of maintenance decreased 35.2 per cent, and operating expenses per 1,000 gross ton-miles were cut 25 per cent. In this particular case a saving of $764,598 per year is being accomplished. This is six per cent on over $12,700,000, which principal amount would buy almost three times the number of locomotives that are required to do the work. If transportation is the life blood of this nation, modern steam locomotives are the red corpuscles of that stream.

Improving the Locomotive Boiler by Research

By Lawford H. Fry
Metallurgical Engineer, Standard Steel Works Company


Lawford H. Fry

The Mechanical Division has as one of its main purposes co-operative study and research directed to the betterment of railroad motive power. The paper is, therefore, planned to show how research can be directed to extending existing knowledge of the locomotive boiler. With this in view the fundamental processes of combustion and heat transfer are surveyed. The boundaries of existing knowledge are mapped out and indications given as to how these boundaries may be enlarged and the benefits that might be expected.

When the total heat energy of the steam produced is compared with the heat in the fuel fired, the overall boiler efficiency is measured. Study of locomotive boiler efficiency dates back to the earliest days of the locomotive. Pambour in 1834 reported tests showing that each pound of coke fired evaporated from five to seven pounds of water. Soon after this it was recognized that the amount of steam produced per pound of fuel—that is boiler efficiency—depended on the rate of firing, the efficiency falling off as the rate of firing was increased. A number of tests on this subject are recorded in the earlier literature, but our more accurate knowledge of the effect of rate of firing begins with the publication of Dr. Goss' experiments made on the first locomotive testing plant at Purdue University. The general relation between overall boiler efficiency and rate of operation was shown, but the information was still not sufficiently detailed to permit the separation of heat production and heat heat absorption, which are the components of the over-all efficiency. This more detailed study first became possible in 1904 when results from the Pennsylvania locomotive testing plant at the St. Louis Exposition were published. Since

then tests made by Dr. Goss on the rebuilt Purdue locomotive, a few tests made at the University of Illinois, and the extensive series of tests made by the Pennsylvania Railroad at Altoona provide information which throws much light on locomotive boiler performance. From these tests it is possible to draw up complete heat balances for each locomotive boiler tested. Typical balances at various rates of operation are given in Table I as a matter of illustration. These balances separate the heat in the coal fired into five items:

1—Heat utilized in producing and superheating steam. This measures the over-all boiler efficiency.
2—Heat lost from the boiler by external radiation. This and the first item make up the total amount of heat taken up by the boiler heating surfaces.
3—Heat lost in the sensible heat in the smokebox gases. This with the first two items makes up the total heat produced by combustion.
4—Heat lost by the production of carbon monoxide, CO.
5—Heat lost by the escape of unburnt fuel. The last two items together make up the amount of heat lost by reason of imperfect combustion.

In addition to the five items of the heat balance as above, Table I contains two further columns giving respectively the efficiency of combustion and the efficiency of heat absorption. These are discussed below, combustion being considered first.

Combustion

The efficiency of combustion will be determined by the amount of combustible, including CO, which escapes from the firebox without having combined with oxygen, and this will depend on the mechanical conditions under which the fuel and the air enter and pass through the firebox. In the case of coal fuel, for which exact numerical information is most abundant, and which is therefore used as a basis of discussion in what follows, it is found that at low rates of combustion from five to ten per cent of the fuel and about 25 per cent of the oxygen will escape from the firebox uncombined. At high rates of combustion the percentages will be reversed and approximately 20 to 25 per cent of the coal and about 10 per cent of the oxygen fail to combine. The loss by production of CO usually appears only at high rates of operation and even then is generally not more than one or two per cent.

Table I—Heat Balances and Efficiencies of Combustion and Heat Absorption

		Heat balance						
			Heat lost				Efficiencies	
Test No.	Dry coal fired per sq. ft. of grate per hour, lb.	Heat utilized in producing steam, per cent	By external radiation, per cent	By heat in the smoke box gases, per cent	By producing CO, per cent	By escape of unburnt fuel, per cent	Of combustion, per cent	Of heat absorption, per cent
6703	18.9	78	3.9	13.5	0	4.6	95.4	85.0
6701	21.5	67	3.4	....	....	....	....	....
6702	22.3	67	3.4	12.6	0	17.0	83.0	85.0
6704	27.0	70	3.5	12.5	2.23	11.7	86.1	85.4
6705	32.3	69	3.5	13.7	1.61	12.2	86.2	83.0
6706	38.2	69	3.5	13.8	1.16	12.5	86.3	83.0
6709	39.3	68	3.4	13.1	.73	14.8	84.5	84.5
6707	49.7	64	3.2	13.8	1.50	17.5	81.0	83.0
6710	50.4	65	3.3	....	....	....	....	....
6715	58.7	65	3.3	12.8	2.04	16.9	81.0	84.3
6708	61.5	63	3.2	13.4	1.68	18.7	79.6	83.2
6711	66.4	60	3.0	11.6	1.59	23.8	74.6	84.5
6716	83.8	61	3.1	13.4	1.67	20.8	77.5	82.6
6712	85.0	59	3.0	11.8	2.00	24.2	73.8	84.0
6717	109.0	59	3.0	13.9	1.64	22.5	75.9	81.8
6713	110.2	56	2.8	12.1	1.45	27.6	70.9	83.2
6714	139.2	53	2.7	11.8	1.04	30.7	67.5	82.5
6721	141.1	53	2.7	12.3	1.94	30.1	68.0	82.0
6723	142.5	53	2.7	....	....	....	....	....
6722	163.3	49	2.5	11.8	1.58	35.1	63.3	81.5
6718	177.0	47	2.4	11.1	1.90	37.6	60.5	81.7
6719	201.3	43	2.2	10.2	1.75	42.8	55.4	81.5
6720	210.6	42	2.1	9.8	2.51	43.6	53.9	82.0

When efficiency of combustion is measured by the heat produced expressed as a percentage of the heat in the coal fired, it is found that in all cases the efficiency falls off as the rate of combustion is increased.

This drop in efficiency of combustion as the boiler is forced to higher rates of operation is largely due to mechanical conditions which prevent the carbon and the oxygen from coming into contact and remaining in contact under circumstaces favorable to their combination. A certain length of time is required for carbon in the solid state, to combine with oxygen, and therefore a certain duration of contact is essential for complete combustion.

This necessity for prolonged contact between carbon and oxygen is one of the factors which makes firebox volume of importance. Combustion in a locomotive firebox at a high rate of operation is by no means confined to the grate. Part of the primary processes of combustion take place on the grate, the larger lumps of coal are heated there and volatile matter is driven off, but above the grate the whole firebox volume is filled with flame in which combustion is taking place. The volatile gases and much of the finer coal are burned in suspension between the grate and the flues, so that the larger the firebox volume and the longer the flame-way, the better is the opportunity for combination between the oxygen and the carbon.

The firebrick arch is of value in promoting efficiency of combustion because it maintanis temperature and increases the length of the flame-way. In stationary boiler practice recent installations provide greatly increased firebox volumes, and rates of operation are commonly measured in terms of coal fired per cubic foot of firebox volume. In locomotive boiler practice the use of combustion chambers is a practical recognition of the value of firebox volume, but in comparing rates of firing it is almost universal practice to do so in terms of coal per square foot of grate area per hour. The evidence on the subject is not entirely conclusive, but leads to the belief that with high volatile bituminous coal, firebox volume is of more importance than grate area in determining the efficiency of combustion; but that with semi-bituminous or hard coal the grate area must be taken into account and must be made sufficiently large to avoid an unduly high intensity of draft through the grate. Further investigation of the value of firebox volume in locomotive boiler design is highly desirable. The test results plotted in Fig. 1 show that with high volatile coal as fuel the grate area in a given boiler can be changed materially without affecting the capacity or efficiency of the boiler. Three series of tests were run with the same boiler, the grate area being different in each series. In Fig. 1-A the efficiency of combustion is plotted against the coal fired per sq. ft. of grate per hr. and three lines result, one for each series. It is evident that the amount of coal fired per sq. ft. of grate does not by itself determine the efficiency of combustion. In Fig. 1-B the same results are plotted, but here the efficiency of combustion is plotted against the amount of coal per cu. ft. of firebox volume. On this basis the results from all three series fall on a single line, showing that with this boiler and this fuel a given amount of coal per cu. ft. of firebox volume produces the same efficiency of combustion no matter whether the grate area be 29.6 sq. ft. or 55.5 sq. ft. Additional, though not quite such striking, evidence of the importance of firebox volume is given by the test results exhibited in Table II and Fig. 2. Table II gives the equations connecting the efficiency of combustion and the coal fired per sq. ft. of grate. These are derived from tests with a number of different locomotive boilers of various designs burning Pennsylvania bituminous coal. These equations give a straight line relation between efficiency and rate of firing and the corresponding lines are drawn in Fig. 2-A with the firing

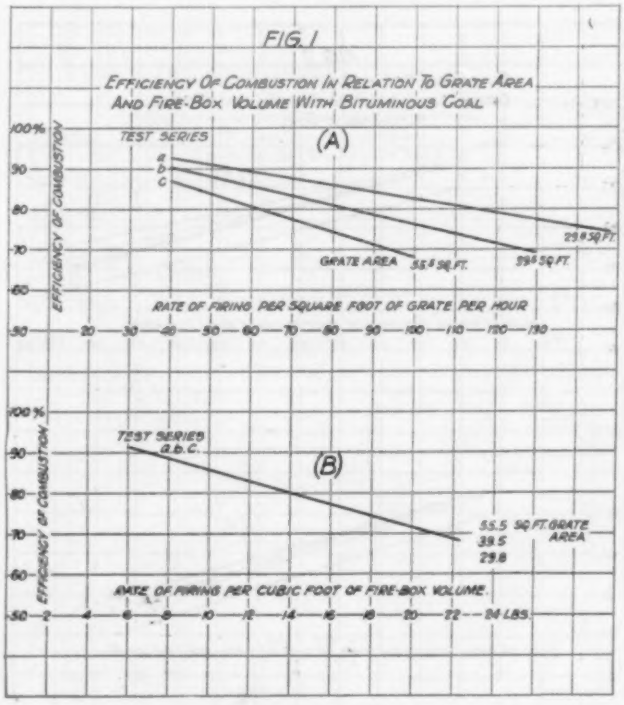


Fig. 1—Efficiency of Combustion in Relation to Grate Area and Firebox Volume with Bituminous Coal

measured in coal per sq. ft. of grate. In Fig. 2-B the lines for the same tests are shown transformed to measure the firing rate in coal per cu. ft. of firebox volume. This latter method of plotting is seen to give less divergence among the lines. Evidence is thus obtained tending to confirm the view that for a locomotive boiler burning bituminous coal the firebox volume is preferable to the grate area as a measure of the capacity for combustion. Further experimental study of the question may be expected to give information of value in enabling locomotive boiler design to be still further improved.

Absorption of Heat by Radiation

Of the heat produced by combustion a part is taken up by the boiler heating surfaces and the remainder escapes as sensible heat in the smokebox gases. The heat absorbed is transferred to the heating surfaces in two ways, by direct radiation and by convection from the hot gases of combustion. Transfer by radiation takes place mainly in the firebox, and probably transfer in the firebox is mainly that by radiation. The amount of heat transferred in any given case by direct radiation can be estimated if the amount of heat produced, the weight of gases of combustion and the firebox temperature are known. From the weight and temperature of the gases the amount of heat carried out of the firebox can be determined, and this will be found to be considerably less than the heat produced. The difference must be the heat radiated direct to the firebox surface and therefore not available for raising the temperature of the gases. According to the Stephan-Boltzman law for radiation, if the firebox were completely filled with an incandescent body of gas radiating under ideal conditions, the heat absorbed per square foot of receiving surface per hour would be proportional to the difference between the fourth power of the gas temperature and the fourth power of the temperature of the receiving surface (see Table III). Examination of a number of locomotive boiler tests in the light of this statement leads to the belief that the heat transfer in the firebox is governed by a law of this kind. It seems necessary, however, to introduce a corrective factor to bring into account the fact that at low rates of combustion the incandescent body of gas does not fill the firebox so completely as it does at the higher rates.

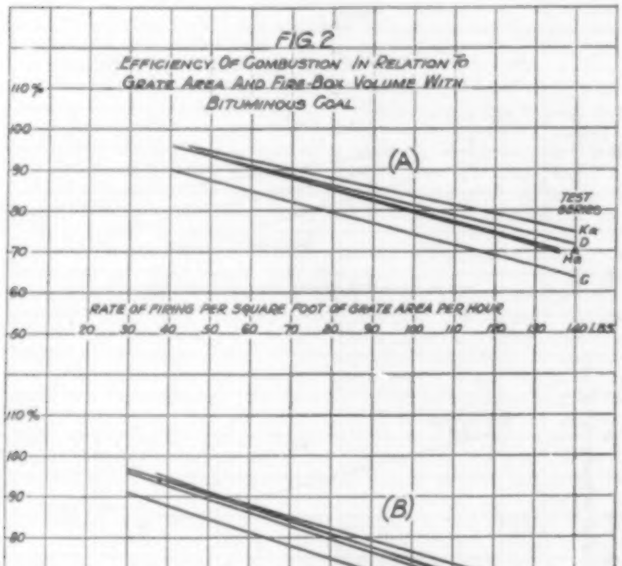


Fig. 2—Additional Tests Plotted from the Results Tabulated in Table II

Table III

Temp., deg. F.	Heat radiated per sq. ft., B.t.u. per hr.	Temp., deg. F.	Heat radiated per sq. ft., B.t.u. per hr.
1,400	18,200	2,100	67,900
1,450	20,500	2,150	73,400
1,500	22,800	2,200	79,300
1,550	25,300	2,250	85,500
1,600	28,000	2,300	92,000
1,650	30,900	2,350	98,900
1,700	34,000	2,400	106,200
1,750	37,300	2,450	113,900
1,800	40,900	2,500	122,000
1,850	44,700	2,550	130,500
1,900	48,800	2,600	139,500
1,950	53,100	2,650	148,900
2,000	57,800	2,700	158,700
2,050	62,700	2,750	169,100

Heat radiated per square foot of receiving surface at various temperature from formula.

$$\text{Heat radiated} = 1600\left\{\left(\frac{T}{1000}\right)^4 - \left(\frac{t}{1000}\right)^4\right\}$$

T = Temperature of radiating gas in deg. F. absolute.
t = Temperature of receiving surface in deg. F. absolute.
Temperature of receiving surface assumed 391 deg. F. = 850 deg. absolute.

It is believed that further study will give a reliable rule for the rate of transfer of heat in the firebox. This is important as providing a correct method for determining the evaporative value of firebox heating surface. Consideration of the data on which the foregoing conclusions are based indicates that the evaporative value of firebox heating surface depends on the firebox temperature, which in turn depends on the relation between rate of heat production, weight of gases of combustion and area of firebox heating surface.

With a given rate of heat production and a given weight of gases the firebox temperature must be such that the heat radiated at that temperature together with the heat carried by the gases at that temperature is just equal to the heat produced. An increase in firebox heating surface would throw matters out of balance unless the firebox temperature were reduced. The original temperature would maintain the rate of radiation unchanged so that the increase in firebox surface would increase the total heat radiated. Since the amount of gas carried heat, which is dependent on the temperature, would not change, the total heat taken out of the firebox would be increased without an increase in the heat produced which is, of course, impossible. To maintain a balance an increase in firebox surface must be accompanied by a drop in temperature, thus lowering the amount of gas carried heat. The lower temperature will give a lower rate of radiation per sq. ft., so that

Table II.—Efficiency of Combustion in Relation to Rate of Firing

Code for test series	Locomotive	Grate area, R, sq. ft.	Fire box volume, V, cu. ft.	V/R	Efficiency of combustion in relation to firing per sq. ft. of grate, Fc = c — dG* c	d	Efficiency of combustion in relation to firing per cu. ft. of firebox volume, Fc = c — d1Gv* c	d1
Ab	Schenectady No. 2	17.0	106	6.3	106	0.258	106	1.62
D	P. R. R. K4s No. 1737	69.3	427	6.1	105	0.237	105	1.45
a	P. R. R. E2a No. 5266	29.8	243	8.2	100	0.170	100	1.39
b	P. R. R. E2a No. 5266	39.5	243	6.2	100	0.235	100	1.39
c	P. R. R. E2a No. 5266	55.5	243	4.4	100	0.316	100	1.39
C	P. R. R. L1s No. 1752	70.0	427	6.1	100	0.263	100	1.60
Ha	P. R. R. I1s No. 4358	70.0	455	6.5	108	0.276	108	1.49
Ka	P. R. R. M1s No. 4700	70.0	494	7.2	105	0.224	105	1.62

*Fc = Efficiency of combustion in per cent.
G = Rate of firing in lb. of dry coal per sq. ft. of grate per hr.
Gv = Rate of firing in lb. of dry coal per cu. ft. of firebox volume per hr.
c, d and d1 are constants for each series of test.
R = Grate area in sq. ft.
V = Firebox volume in cu. ft.
d1 — V/R d.

though the total heat radiated will be greater with the greater surface, the increase in heat radiated will not be in proportion to the increase in firebox surface.

Information available at present allows the foregoing statements to be made with confidence, but knowledge of this important subject is by no means complete and research would undoubtedly produce valuable results.

Transfer of Heat by Gas Convection

The general problem of the transfer of heat by convection from a gas flowing through a flue has been studied by many experimenters. By combining the results of a number of these studies a formula has been developed to give the drop of temperature as the gas passes along the flue. See Table IV. This is a double exponential formula and shows that the temperature drop along the flue depends on the temperatures of gas and of flue, on the flue dimensions and on the rate of gas flow in the flue. It has been used with success to estimate the general condition of heat transfer in locomotive flues and will give a high degree of accuracy if the method of determining or estimating the flue wall temperature is perfected. Fig. 3 and Table IV show the results obtained by using the formula to compute the temperature drop along the boiler flue. The rate of temperature drop is shown for two cases in which the only difference is the rate at which the gas flows through the flue. One case has a rate of gas flow corresponding to what might be expected in a locomotive boiler at the maximum rate of operation, while in the second the rate of gas flow is half that of the first. In passing 20 ft. through the flue the gas temperature, which is assumed to be 2,600 deg. F. on entering the flue in both cases, drop to 625 deg. F. under high power conditions and to 545 deg. F. when the rate of gas flow is halved. This agrees with the usual experience that as the rate of operation is reduced the smokebox temperature is lowered. Translated into terms of heat taken up from the gases of combustion, these temperatures show that the amount of heat given up by each of the 300 lb. of gas flowing at the high rate is about four per cent less than the amount given up by each pound of gas at the low rate. Put the other way round the heat taken from each pound of gas at the high rate is 96 per cent of that taken up at the low rate of gas flow, but as the total weight of the gas is double, the total amount of heat taken up is increased in the proportion of 192 to 100. Doubling the rate of gas flow very nearly doubles the total amount of heat transferred from the gas to the flue. The heating surface of the flue is, of course, the same in both cases. This is an extremely important proposition. Among other things it shows that if half the tubes in a locomotive boiler were plugged and if it were possible to maintain the same total amount of gas flow as before, the doubled rate of flow in the remaining flues would increase the activity of heat transmission to such an extent that the evaporative power of the boiler would be reduced by only about four per cent. It becomes evident therefore that the major factor in determining the evaporative power of the flues is not the area of heating surface they offer, but the amount of gas that can be taken through them. In an actual locomotive boiler working at high power it would not be practicable to plug half the tubc. and still maintain the same total rate of gas flow. The increase in draft required to move the same amount of gas through half the number of flues would be prohibitive. It is, however, a matter of fairly common experience that a considerable number of flues can be blocked up without reducing the capacity at all proportionately. Applied to the superheater flues, the formulas which have been used to find the curves of Fig. 3 show similar curves, but with a slightly more rapid drop of temperature. This would indicate that the gases emerging from the superheater flues would have a slightly lower temperature than the gases which come through the plain flues. In view of the higher steam temperature in the superheater pipes this is not exactly what might have been expected, but there is some experimental evidence in its support.

Table IV—Heat Drop Along 2-In. Flue by Formula

Distance along flue, ft.	With 300 lb. of gas flowing through flue per hr. — Gas temperature, deg. F.	Heat carried per lb. of gas, B.t.u.	Heat given up per lb. of gas from entrance of flue, B.t.u.	With 150 lb. of gas flowing through flue per hr. — Gas temperature, deg. F.	Heat carried per lb. of gas, B.t.u.	Heat given up per lb. of gas from entrance of flue, B.t.u.
0	2,600	706	0	2,600	706	0
1	2,305	617	89	2,250	600	106
2	2,060	543	163	1,960	514	192
3	1,850	482	224	1,730	448	258
4	1,670	431	275	1,535	394	312
5	1,520	389	317	1,380	350	356
7	1,280	323	383	1,130	282	424
9	1,100	275	431	960	238	468
11	960	238	468	825	213	493
14	810	199	507	697	170	536
17	700	171	535	608	148	558
20	625	152	554	545	132	574
23	565	137	569	500	121	585
26	525	127	579	470	113	593

The entering temperature is taken as 2,600 deg. F. and the flue wall temperature as 390 deg. F.

The temperature drop is given by the equation: $\text{lolog}\,(T1/t) - Mx = \text{lolog}\,(T2/t)$.

Where "lolog" means logarithm of the logarithm of a number.

T1 is the absolute gas temperature at any point and T2 is the absolute gas temperature at a point x feet along the flue.

M is a coefficient depending on the flue diameter and rate of gas flow in accordance with the following equations:

$\log M = B - m \log W/P.$

$\log (B + 1.3) = 9.71 - 0.54 \log d.$

$\log m = 9.36 + 0.37 \log d.$

Where W is the weight of gas in lb. flowing per hour through the flue.

P is the inside perimeter of the flue in inches.

d is the inside diameter of the flue in inches.

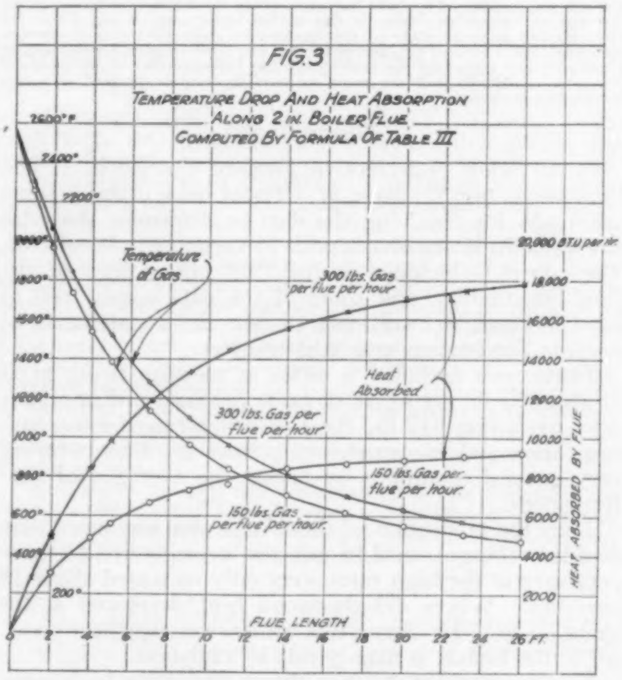


Fig. 3—Chart Showing Temperature Drop and Heat Absorption Along a 2-in. Flue

The formulas as at present established are of value in showing how heat transfer by convection is affected by the various factors, rate of gas flow, temperature, diameter and length of flue. To apply them though, at present, it is necessary to make certain assumptions as to the relative distribution of gas between the superheater and the plain flues, and also as to the wall temperature of the flues. Further research to throw more light on these points would make the formulas of still greater value in analyzing locomotive boiler design.

Before leaving the subject of heat transfer it may be noted that the transfer by convection in the flues is to a certain extent dependent on the transfer by radiation in the firebox. An increase in firebox surface while increasing the heat taken up by radiation reduces the temperature at which the gases enter the flues and therefore reduces the heat available for absorption by convection.

If the total efficiency of heat absorption, that is the total heat taken up by the boiler expressed as a percentage of the heat produced, is studied it is found that in any given boiler the efficiency of heat absorption is only slightly affected by the rate of operation, the variation between minimum and maximum power being usually less than four per cent. Actual values of the efficiency of heat absorption depend on the boiler design, and show a range of from 75 to 85 per cent at maximum power.

To complete the survey of the boiler in action attention must be given to the conditions under which the air for combustion is supplied. Since George Stephenson's time the locomotive boiler has been distinguished by the use of the exhaust steam from the cylinders to draw the air for combustion through the fire. Though the method has often been criticized as theoretically inefficient its simplicity and practical advantages have maintained it in universal use. In spite, however, of the fact that

all locomotives use exhaust steam in a blast pipe to produce draft there is very little organized theoretical knowledge as to the details of this fundamental process. The research carried out in 1896 by Dr. Goss for the Master Mechanics Association could with great profit be brought up to date and further extended to provide a solid scientific basis for front end design.

Summary

As a final word may I quote some remarks I made recently before the American Society of Mechanical Engineers in a discussion of locomotive testing plants:

> A very great step forward could be made if the American Railway Association were to construct or to take over a locomotive testing plant to be devoted to the scientific and impartial study of locomotive designs and devices, and to undertake research work concerned with the basic scientific laws governing locomotive operation. Correct locomotive design is based on definite natural laws, knowledge of which can be obtained only by accurate experiment. The great influence which the locomotive testing plant has had on locomotive design is due to the opportunity it has given for thorough and accurate study of the fundamental laws governing locomotive operation. It is evident that the wider and the more accurate the knowledge a designer has regarding the laws governing the operation of his product, the more confidently and the more successfully can he proceed with improvements in design.

Discussion

C. A. Seley (Locomotive Firebox Company): The locomotive testing plant at Urbana was utilized some years ago for obtaining the data to determine the relative value in locomotive service of various grades of coal. The report is included in the 1917 proceedings of the Fuel Association, and some of the data comes well to hand in checking over some of Mr. Fry's statements as regards combustion and heat transfer.

These tests included a series at medium firing rates or about 52 lb. per sq. ft. of grate per hour and at higher rates averaging 112 lb., the fuel being run-of-mine, nut, egg, lump and two grades of screenings, thus covering very general conditions by taking the averages of performances.

Thus the proportion of the firing rates was more than doubled, being 1 to 2.15 but the average firebox temperatures at the high rates were only increased about 18 per cent. Where did the extra heat developed at the grate go to? Mr. Fry gives the answer that heat transfer in the firebox is mainly that by radiation.

Further study of the data shows that at the high rates, the total evaporation was increased 80 per cent and its total temperature 7 per cent, the balance being loss due to the higher rate in increased stack loss and slight increase of front end temperature.

I do not wish to give the impression that heat transfer is entirely by radiation, as the firebox gases although increased only 18 per cent in temperature do contribute somewhat by convection to firebox evaporation, and altogether by convection to the heat transfer in the flues.

Doubling the rate of flow very nearly doubles the total amount of heat transferred from the gases to the flues. I am glad to find the same statement in this paper and its truth is evident from the tests referred to. With the coal rate more than doubled, requiring increased air for combustion, and getting it, as shown by increased draft readings, the volumes of gases was likewise increased, with a further increase of temperature of 18 per cent due to evaporation and superheating for the higher rates of combustion and output.

It is rather interesting to note the figures of the drop in 10 ft. of flue length, as 545 deg. and 625 deg. F. respectively for the single and doubled rates of flow. It so hannens that the averages for the tests above referred to are 549 and 626 deg. F., being the readings of front end temperatures with 21 ft. length of flues. The formula from which Mr. Fry's figures are derived assumes a 2,600 deg. F. temperature of the gases entering the flue.

The average firebox temperatures of the tests at Urbana were 1887.5 deg. and 2224.3 deg. F. respectively for the medium and high firing rates.

Other tests ran from 2,087 to 2,518 deg. F., 2,337 deg. F. average in the firebox; about 1,500 deg. F. at the flue sheet and about the same figures for the front end as stated in the report, the flues being 20 ft. long.

A curve much flatter than shown on page 16 of the report would be produced under both of these conditions. It is of course very difficult to obtain flue gas temperature readings, except in the front end where there is a mixture of the gases from the superheater and non-superheater flues. Judging from front end and furnace temperatures on record, a typical curve of drop of flue gas temperatures would begin with a decided drop from that of the furnace, due to the change of method of heat transfer and absence of radiation; this drop continuing for the first foot or two, then flattening but with considerable pitch for approximately half the flue length, in which the main transfer of heat from the flues is accomplished. The curve then flattens more, as in the last half of the flue length there is a more slowly decreasing rate of transfer as the spread between the respective temperatures of the gases and of the water surrounding the flues gradually decreases.

H. H. Lanning (A. T. & S. F.): There should be some relation established between the grate area and the firebox volume. Of course this ratio, if it is possible to arrange one, will vary for different fuels and different grades of fuels. I would like to ask Mr. Fry if any consideration has been given to the development of such ratios or if they are possible?

Mr. Fry: I want to emphasize the fact that I was not arguing for firebox volume as against grate area. I was trying to point out that we do not know enough about the relation between firebox volume and grate area, and that it would be very desirable to have some further accurate experiments which would give us a law for that relation.

T. W. Demarest (Penn.): There are some questions which occurred to me. In the first place, what should be the weight of the bridge in the flue sheet? What relation has the spacing of the tubes to the heat transferred from the tube to the water which must pass up between the tube banks? Is our staggered tube spacing today, which has not been changed for years, the advisable spacing? Should we go a step further? Should we use a combination of staggered spacing with vertical clear passages?

Besides proper tube length or tube ratio, we have got to think of something else, and that is whether the passage of the water by the tubes through the tube bank is sufficiently rapid or in sufficient volume to permit the proper taking up of the heat which passes through the tube wall?

The position today in stationary practice is that the maximum utilization of the heat of combustion is through adding additional radiant heating surface. It does not seem to me that the present firebox design with a large cross-section area and a large combustion chamber is so designed as to permit you to make the maximum use of the radiant heat.

A. I. Lipetz: The question of spacing the tubes has been tried and tested, and no results have come out of this trial simply for the reason that the question was not followed up to the end. It is true, as Mr. Fry said, that the locomotive boiler is not well known. But why is it? Because the American railroads are not fully taking the opportunity of making road tests. There are several testing plants in the United States. The Altoona testing plant gives valuable information which is being used on this continent and abroad, but other testing plants are not big enough to test the present day large locomotives. Nevertheless the railroads could test locomotives, if they would simply agree to test them under the same con-

ditions as in some European countries. I do not want to create the impression that I am opposed to testing plants, but I know that it is not easy to build a testing plant. It requires much money, and much resistance must be overcome before a testing plant can really be put in service. But to test a locomotive on a road and get information sufficiently accurate in order to know all about the locomotive boiler is an easy matter.

This morning, I mentioned that when the Russian government built the oil-gear locomotive, they tested it very thoroughly on a testing plant. They were not satisfied with that, and tested the same locomotive on a long piece of track with uniform grades under constant conditions. They obtained figures which were in agreement with data obtained on the testing plant.

This proves my contention that road tests under constant conditions, when the railroad is fortunate enough, or, better, say, unfortunate enough to have very long grades, can be made accurate enough for railroad use.

If a railroad has sufficiently long stretches of either uniform grades, or levels, they can make sufficiently good tests until it is in a position to build a testing plant.

Report on Locomotive Design and Construction

H. T. Bentley
Chairman

Your committee has, during the year, given consideration to the following subjects:

Standardization of fundamental parts of locomotives.
Rail stresses under locomotives.
Use of three-cylinder locomotives versus two-cylinder types.
Provision for expansion of locomotive boilers on the frames; also firebox supports.
Exhaust steam injectors.
Advantages and disadvantages of boiler pressures higher than 200 lb.
Development and use of oil-electric locomotives.

Standardization of Fundamental Parts of Locomotives

Realizing that the scope of the subject could not be covered in a single year's work, the committee has limited its work this year to the standardization of driving, engine truck and trailer axles of steam locomotives, together with such features of wheel and box construction as are interlocked with the standardization of axles. In its investigation, the committee attempted to gather information from a large number of representative railroads in the United States and Canada, as well as from all the locomotive builders, but was only partially successful. However, the information obtained is sufficient to show that any standardization of fundamental locomotive parts for existing locomotives is practically impossible. The committee has, therefore, proceeded to outline standards which they believe could be consistently followed in the construction of new power. We have also endeavored to limit the number of different axles to the smallest number that can be made to meet all requirements.

The committee feels that it is good engineering practice to design all axles and boxes so that the bearings will be uniformly loaded as a result of piston thrust, as well as weight carried on the axle. The designs recommended therefore show frames and seats for springs and spring saddles located centrally with respect to the bearings.

Information received shows a wide variety of practices with regard to the relative diameters of wheel fits, journals, and centers of axles. The practice of making wheel fits slightly larger than journals, centers, or other adjacent parts of the axle, is almost universal and is recommended because it has proved effective in preventing the origin and development of progressive fractures within the wheel fit, where they are difficult, if not impossible, to detect by inspection. Reduced or tapered center axles are used by some roads for driving and truck axles which have bearings between the wheels. Other roads appear to favor driving and truck axles with straight centers, rough-turned to the same diameter as the journals, for the reason that trouble has been experienced on account of failures occurring in the reduced diameter centers. It is felt by the committee that the elimination of all unnecessary offsets or changes in section is an important step in the prevention of progressive fractures. The committee therefore recommends that driving and engine truck axles, having journals located between the wheels, be of the straight-center type except that the diameter of the axle between journals may be reduced to correspond to the nominal diameter of a new journal minus the limit of wear allowed by the road using the axle.

Many roads follow the practice of tapering the centers of trailer axles which have bearings outside the wheels, the tapered centers of these axles being proportioned substantially in accordance with the standard practice for car axles. It is noted, however, that when boosters are applied to trailer axles, the use of the straight center axle is universal and since some of the roads favor the straight-center axle under all conditions, the design submitted shows straight-center axles for all trailer trucks.

The practices of the different roads with regard to the application of collars on the ends of trailer axle journals vary widely, the roads replying being about evenly divided between the collared and collarless axles. The situation with regard to the reduced diameter neck between journals and wheel fit of trailer axles is substantially the same. The committee has therefore made these features optional, as their inclusion or omission is merely a matter of machining. It is noted that most roads find it necessary to control the lateral play of trailer wheels by hub face bearings applied to wheels and boxes. The committee therefore recommends that the journal bearings of trailer axles be formed as close to the hub faces of the wheels as surrounding conditions will permit. This practice has the effect of reducing the spread of trailer truck journal boxes, as well as the fiber stresses in the axles.

Fig. 1 shows the practices recommended by the committee for driving axles. Fig. 2 lists the sizes and dimensions of driving axles that are recommended. Attention is called to the fact that only eight different sizes, advancing by increments of 1 in. from

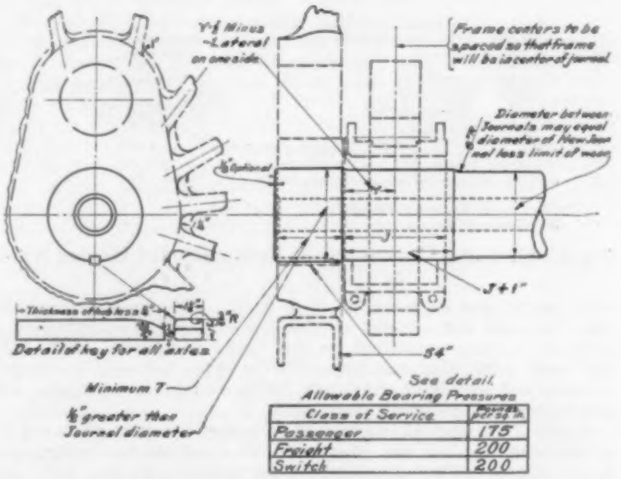


Fig. 1—Recommended Practices for Driving Axles

7 in. to 14 in., inclusive, in diameter, are proposed. It is believed that the sizes listed can be made to satisfy all requirements in designing new power, but the committee has been advised of cases in which roads have been compelled to use axles of certain intermediate sizes in order to avoid exceeding limitation of weight. The committee, in its future work, expects to keep in touch with this phase of the situation, with the idea of recommending additional sizes, if such becomes necessary. It is recommended that the dimensions of driving axles other than main be governed by the weights carried on the axles and the journal bearing pressures produced thereby. The dimensions of main driving axles should be governed by the fiber stresses produced by piston thrust unless the dimensions thereby arrived at give bearing pressures that are above the limits recommended. In such cases the dimensions of main axles should be governed by the weight carried on them and the bearing pressures resulting therefrom. The standard driving wheel design adopted in 1907, as reflected by page 3, Section

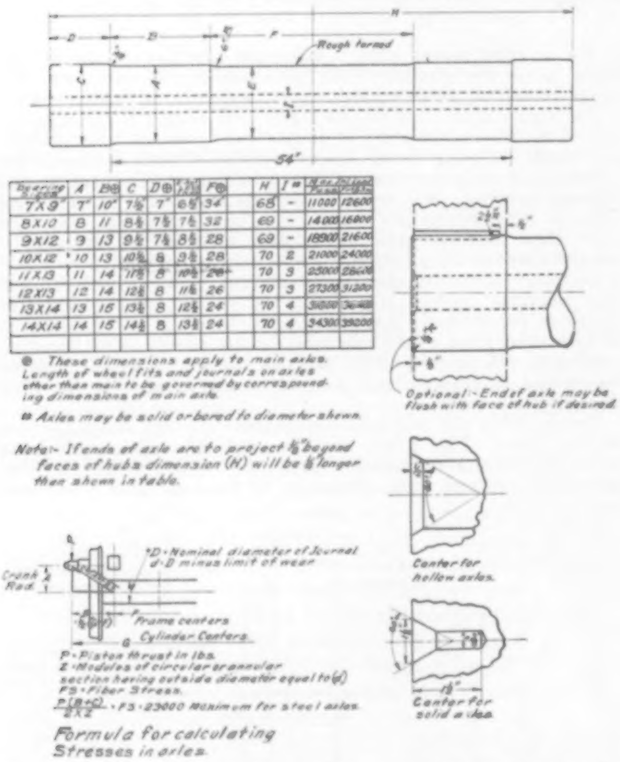
F, of the Manual, calls for a standard distance of 55 in. between driving wheel hubs. The work of the committee indicates conclusively that this standard hub spacing is not being followed and cannot be consistently followed in the construction of heavy modern power. It is therefore recommended that hubs of driving wheels be spaced 54 in. apart.

Fig. 3 shows the practices recommended for engine truck axles; Fig. 4 lists sizes and dimensions of engine truck axles recommended and Fig. 5 lists the sizes and dimensions of axles recommended for trailer trucks of the two-wheel type.

The report of the sub-committee on Standardization of Fundamental Parts of Locomotives is signed by H. H. Lanning (chairman), A. Kearney, and W. L. Bean.

Rail Stresses under Locomotives

At the 1924 meeting, an individual paper on Relation of Track Stresses to Locomotive Design, was submitted by C. T. Ripley,



Bearing Sizes	A	B	C	D	E	F		H	I	[illegible]	[illegible]
7X9"	7"	10"	7½	7"	6⅝	34"		68	-	11000	12600
8X10	8	11	8½	7½	7½	32		69	-	14000	16000
9X12	9	13	9½	7½	8½	28		69	-	18900	21600
10X12	10	13	10½	8	9½	28		70	2	21000	24000
11X13	11	14	11½	8	10½	26		70	3	25000	[illegible]
12X13	12	14	12½	8	11½	26		70	3	27300	31200
13X14	13	15	13½	8	12½	24		70	4	[illegible]	[illegible]
14X14	14	15	14½	8	13½	24		70	4	34300	39200

Fig. 2—Sizes and Dimensions of Recommended Driving Axles

chief mechanical engineer, A. T. & S. F. This paper referred to the first tests and surveys on this subject, and also embodied a number of tests conducted on the Santa Fe during 1922, 1923 and 1924, with Mountain type, Pacific type, balanced compound Prairie, and both light and heavy Santa Fe type locomotives. No definite recommendations were made.

At the 1926 meeting, there was submitted a report prepared by a subcommittee of the committee on Locomotive Design and Construction. This consisted of an analysis of the test data reported in 1923 by the A. R. A. and A. R. E. A. special committee on Stresses in Railway Tracks, and by C. T. Ripley at the 1924 session. The committee confined its analysis to steam locomotives of the Pacific, Mountain, Mikado and Santa Fe types.

The report suggested that the distribution of weight be given consideration when designing Mikado, Mountain and Santa Fe type locomotives. No definite recommendations were made which could be formulated to permit of calculating stresses produced in rails under the locomotives due to their mechanical construction.

The subcommittee appointed to make a further study and report at the 1927 meeting, endeavored to secure more recent information of tests that were conducted during 1926, but on account of the test data not being completed, they were unable to embody it in this report.

With reference to information that has been given out by some locomotive builders, relative to low rail stresses produced by three-cylinder locomotives, we have nothing to substantiate this argument, other than the generally accepted principle that a better balance of moving parts reduces speed effects.

After reviewing all available information it is recommended that a joint committee be appointed, comprised of members of the A. R. E. A., who have already made a study of this subject and have accumulated considerable information in connection with it, the A. R. A. committee on Locomotive Design and Construction, and the committee on Electric Rolling Stock. The latter committee has prepared considerable data on the subject with reference to the effect of electric locomotives on rails.

It is further recommended that the A. R. A. give the necessary authority to have additional tests conducted by some well equipped university, such as Purdue or Illinois, which is competent to conduct tests of this character, with the understanding that the above committees co-operate closely with the university selected. Furthermore, if the above recommendations are approved, previous tests and reports should be given consideration, as no doubt the committee will find this information of help in making final report and recommendations.

When conducting these tests, modern locomotives should be used of the types mentioned, and in addition thereto, both the three-cylinder simple and the three-cylinder compound, and also locomotives equipped with 4-wheel trailing trucks. Furthermore, when making this investigation and tests, the different weights of rails and the different methods of ballasting should be considered, as from observation, it would appear that this feature would play a prominent part in arriving at definite conclusions.

The report of the subcommittee on Rail Stresses under Locomotives is signed by W. I. Cantley (chairman), A. H. Fetters, M. F. Cox and H. M. Warden.

Three-Cylinder Locomotives versus Two-Cylinder Type

It would seem pertinent to give a brief history of the three-cylinder locomotive in the United States, as it dates back at least to 1848. [The introductory historical portion of this report is omitted.—Editor].

In 1922, the American Locomotive Company converted a two-cylinder 4-8-2 type locomotive to a three-cylinder engine for the New York Central. Several radical departures in design were noticeable on this locomotive, the most important of which was the use of the Gresley gear developed on the Great Northern Railway in England. The second three-cylinder locomotive, a 4-8-2 type built by the American Locomotive Company, was delivered to the Lehigh Valley in October, 1923. Within a period of two or three months after it was placed in service, a number of test runs were made which showed fuel economy, ability to make up time with heavy trains, freedom from lurching and

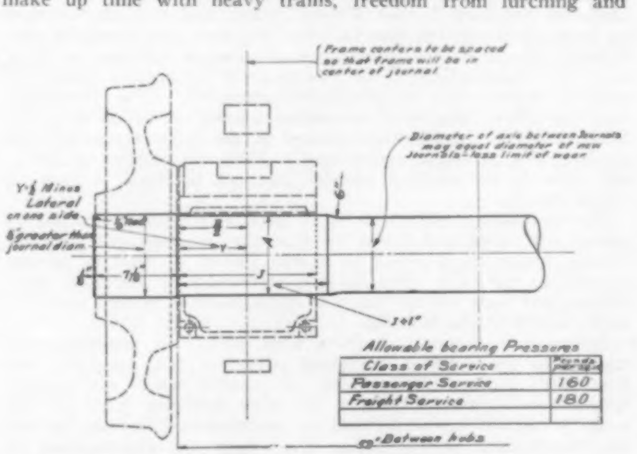


Fig. 3—Recommended Practices for Engine Truck Axles

vibration at high speeds, and ease in starting, it being possible to get a heavy train under way with a noticeable absence of jerking.

Since the installation of these two locomotives, which in a strict sense are the real pioneers of the modern three-cylinder locomotive in this country, there have been, up to the present time, 138 three-cylinder engines built for various roads of the United States. Not the least interesting recent development is the three-cylinder compound locomotive No. 60,000,* a 4-10-2 type, built by the Baldwin Locomotive Works during the early part of 1926. The locomotive was submitted to extensive tests on the Pennsylvania Railroad's locomotive test plant at Altoona, and is now being tested out in road service on various roads.

There are many more three-cylinder locomotives in service in foreign countries than in this country, Germany being in the

*For a description of this locomotive, see the Daily *Railway Age* for June 14, 1926, page 1773.

lead with approximately 2,000. In England, there are about 250, and 100 distributed among other countries, making a total of about 2,350. A considerable number of these have been in service from 10 to 15 years.

There seems to be no doubt, therefore, that the three-cylinder locomotive has some decided advantages over the two-cylinder design. At the same time, as in most improved mechanical devices, it also carries the usual disadvantages of having an increased number of parts and requiring more care in design and maintenance.

It would appear that improvements made in material and design of the crank axles have overcome the weakness of this detail in the earlier construction, as the modern three-cylinder locomotives have been remarkably free from this defect, only one failure having come to our attention of the 138 locomotives in service in the United States.

For the purpose of collecting data for this report, 24 questionnaires were sent out. Thirteen were sent to roads operating three-cylinder locomotives in this country; three to roads operating three-cylinder locomotives in Europe; and five to prominent roads in this country that have no three-cylinder locomotives in operation, in order to get their views. Replies were received to all our circulars other than those sent to foreign countries, the replies to the latter hardly having had time to reach us. While all of the five roads not operating these locomotives replied, four did not make any comments and one quoted several advantages which rather appealed to them.

The number of three-cylinder locomotives in service on the different roads of this country vary from one to thirty-nine. The types also have a great range, as shown in the following tabulation, which gives the number of locomotives for each type reported, together with their tractive forces and factors of adhesion:

Type	No. of locos.	Tractive force, lb.	Factors of adhesion
0- 8-0	11	60,600 to 66,300	4.05 to 3.9
2- 8-2	7	65,700 to 67,870	3.7 to 3.74
4- 6-2	3	46,400 to 47,100	3.77 to 4.05
4- 8-2	51	61,100 to 77,600	3.54 to 4.19
4-10-2	49	78,000 to 84,200	3.7 to 3.77
4-12-2	15	96,650	3.67

This brings out the fact that the three-cylinder principle can be adapted to all standard types commonly used for modern two-cylinder locomotives, and in case of one recently introduced type, the 4-12-2, it is scarcely probable that two outside cylinders would be seriously considered in combination with six pairs of coupled drivers.

These locomotives are in service as follows: Hump yard switching, transfer, freight, fast freight, milk trains, express trains and passenger.

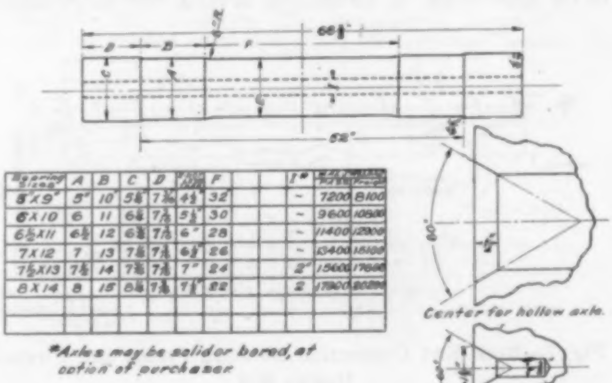


Fig. 4—Sizes and Dimensions of Recommended Engine Truck Axles

The cylinders range in diameter from 22 in. to 27 in., and are obviously much smaller than would be required to develop the same power if only two cylinders were used. This reduction in cylinder diameter, in addition to reducing stresses set up in machinery and frames, allows reciprocating parts to be much lighter, resulting in less counterbalance in the wheels, and, consequently, in less dynamic augment. Where cranks are set at 120 deg. instead of 90 as on two-cylinder locomotives, there is a further reduction in dynamic augment owing to avoiding the combined effect of two counterbalances acting at one time on either the rail or the locomotive. The result is that stresses set up in roadbed and bridges due to counterbalance are reduced about one-third, thus permitting static wheel loads to be increased by a like amount.

Furthermore, the use of smaller cylinders not only reduces the leverage on main axles and crank pins, thus decreasing the stresses set up in these parts as well as in frames, wheel and their component parts, but also permits a greater cylinder capacity within the same overall measurement of cylinders.

At slow speeds the factors of adhesion of the locomotives reported range from 4.19 to as low as 3.54, all but 17 of the locomotives being less than 4.0. For two-cylinder locomotives the adhesion is nearly always well above 4.0. The low adhesion is made possible only by the use of a third cylinder, which produces a more uniform pulling torque. In any locomotive the adhesive weight must be great enough to prevent slipping with the maximum tractive force developed through a complete revolution of the drivers. The increase of this maximum over the average is much smaller for a locomotive with three cylinders than for one with two cylinders. Hence, for a given weight on drivers, the three-cylinder locomotive can develop from 10 to 15 per cent more rated tractive effort than a two-cylinder design without slipping the wheels.

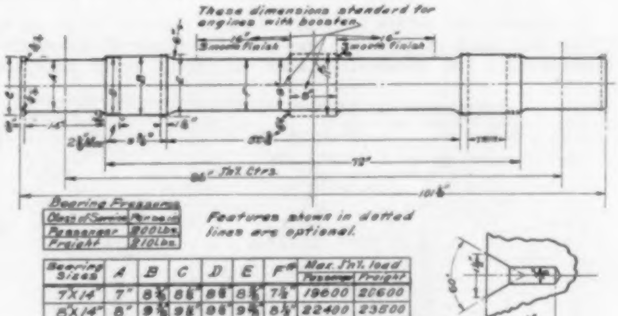


Fig. 5—Sizes and Dimensions of Recommended Trailer Truck Axles of the Two-Wheel Type

Restricted cutoff is in use on three-cylinder locomotives in Europe and has been embodied in these locomotives on two roads in this country with satisfactory results.

The questionnaire asked for cost of repairs on a ton-mile basis for three-cylinder locomotives compared with two-cylinder locomotives in the same service. Four roads answered on this basis, three on a mileage basis, and six did not answer. Of those replying on a ton-mile basis, three roads report respective savings of 7.5 per cent, 23.9 per cent and 28 per cent for the three-cylinder, while the fourth states that the repairs are only 25 per cent of that of a two-cylinder engine. On a mileage basis, the figures furnished by one road shows 0.43 per cent increase in cost for the three-cylinder, and by the other road, 21.8 per cent saving.

The question regarding fuel consumption for three-cylinder locomotives compared with two-cylinder locomotives in the same service was answered by nine roads, all on a ton-mile basis. The reports show a saving of from 3 to 18 per cent for the three-cylinder.

In answer to the question "What per cent increase or decrease in tonnage per 1,000 lb. weight on drivers do three-cylinder locomotives haul as compared with two-cylinder type?" all roads except two report an increase of from 3 to 20 per cent. The two exceptions are as follows: One road rates the three-cylinder the same as an equivalent two-cylinder locomotive; another road gives the same rating for both types on a 0.4 per cent ruling grade, but states that on various momentum grades up to 0.9 per cent the three-cylinder locomotive shows as high as 9 per cent increase in tonnage.

Two of the three locomotive builders are building three-cylinder locomotives, both agreeing that these engines have the following advantages over the two-cylinder type:

1—More uniform torque and greater tractive force.
2—A much better balanced condition.
3—A more uniform exhaust pulsation, resulting in better draft conditions, and slight increase in boiling capacity.
4—Lower factor of adhesion.

Roads operating three-cylinder locomotives have also mentioned advantages over the two-cylinder design as follows:

1—Increased tractive force, greater starting power, more rapid acceleration and lower factor of adhesion, due to more uniform torque produced by six power impulses per revolution. For these reasons they are equally advantageous in switching, hump or drag, freight or passenger service.
2—More perfect counterbalance, thus reducing stresses set up in machinery, bearings, boxes, frames, roadbed and bridges, and permitting increase in weight on drivers and greater speed with better riding qualities.

3—Greater cylinder capacity with given clearance limitations and road-bed conditions, and, due to smaller outside cylinders, less leverage and stresses in axles, crankpins, frames, wheels and their component parts.

4—Less slipping, with less tire and rail wear, greater mileage between repairs and between tire turnings, increased gross ton-miles per hour, lower cost of maintenance and operation, and saving of fuel and water on account of three cylinders permitting operating at shorter cutoff for a given power output.

5—Due to the greater number of exhausts per revolution, exhaust nozzle can be opened wider, thus reducing back pressure, causing a milder and more even draft on the fire, and increasing boiler efficiency.

6—Permits dividing application of driving power to two axles instead of one, thus reducing stresses set up and increasing life of parts affected.

The report of the subcommittee on Three-cylinder Locomotive versus Two-cylinder Type is signed by George McCormick, (chairman), S. Zwight and C. E. Brooks.

Provisions for Expansion of Locomotive Boilers on the Frames

To support and secure satisfactorily a locomotive boiler on its frame has been of interest since the beginning of locomotive construction; but locomotives built in recent years have, on

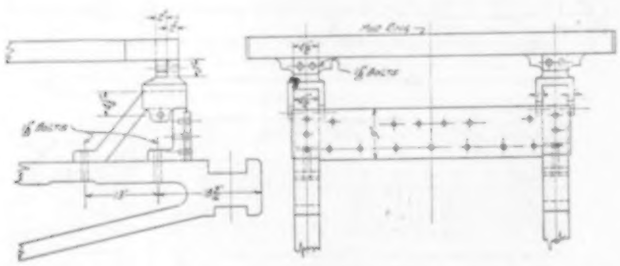


Fig. 6—Back End Connection Between Frame and Firebox, Design B-3

account of their increase in size and capacity, added some difficulties to the problem of designing supports of sufficient stability and, at the same time, providing for the expansion of the boiler on the frames.

A large number of drawings have been secured from locomotive builders and many roads, from which some 72 have been selected to show the typical forms developed in the progress of locomotive design, and it is the thought that an assembly of these designs might not only serve as a history of what has been done, but also afford some idea of the trend of thought, experience and opinion as locomotives have grown in size and capacity. In the study of this subject it does not appear to be possible to lay down any definite formulae covering either general or detail construction.

These designs have been divided into groups, as follows:

1.—In the group of drawings designated as "G," and numbered to show the consecutive time of their introduction in locomotive construction, will be found designs of support located near the cylinder, and which for convenience are referred to as "guide braces."

2.—In group "W," will be found designs showing waist sheets, which are the connections back of the guide yoke or back of the cross bar supporting the valve gear.

3.—In group "F," is shown the connection between the frame and the front end of the firebox.

4.—In group "B," is shown the connection between the frame and the firebox at the back end of the firebox.

5.—In group "S," are shown boilers with expansion pads on the side, and these expansion pads are also used on boilers with fireboxes between the frames or directly over the frames. These are mostly of earlier date than those marked "F" and "B."

6.—In group "C" are shown crossties which rest on the frame, tying the two sides of the locomotive firebox together, in most cases acting as support for the grate bars, and in a measure supporting the back end of the boiler under the firebox.

7.—Group "M" represents a special connection used on Mallet locomotives, attaching, with lateral sliding action, the front end of the boiler to the front engine frame.

In the first group marked "G" we have used a suffix, the letter "N," to represent, for ready reference, the devices that are not attached to the boiler. It will be noted that a large proportion of the connections we have shown are attached to the boiler. The information we have shows that where the sheets are very short in depth, less than 5½ in., it is the practice of some to leave them free at the boiler. In this case, a liner is placed on the bottom of the boiler to take up the wear. Some roads, however, use a loose connection for these guide and waist sheets, regardless of the depth, and others report that the loose connection between the sheets and boiler has not been satisfactory and they have changed to a support that is riveted or studded to the boiler.

Several in the group "W" also have the suffix "N" after the numeral, indicating that some of these waist sheets are not attached to the boiler, but form a support for the boiler without any direct attachment.

The most common trouble with both guide yoke and waist sheet connections has been the loosening of the rivets or bolts connecting the sheets with the tee iron on the boiler and connecting the sheets with the frame cross brace. To overcome this trouble at both the guide yoke sheets and the waist sheets, the following improved methods have been developed:

(a) Increasing the number and size of bolts used in attaching the sheets to both the frame cross braces and to the boiler tee irons.

(b) Riveting of extra plates at the top and bottom to provide additional bearing of the bolts or rivets. See Fig. W-15.

(c) Putting in a double set of sheets at the particular points, in order to get double bearing areas without decreasing the flexibility. See Fig. G-8.

(d) Providing a lip on the frame cross braces so that the sheets can rest on this lip and thereby afford better support. See Fig. W-9.

(e) Use of cast steel expansion plates with the flange which is attached to the boiler cast integral with the plate. See Fig. W-13 and Fig. G-13.

(f) Use of cast steel expansion plates with the flange cast integral with the plate for attachment to the frame crossties, as well as to the boiler. See Fig. G-13 and W-13.

(g) Doubling the bolt bearings by using two plates riveted together and two angles on boiler. See Fig. W-10.

(h) Application of a sheet between the bottom of the tee iron on the boiler and the top of the frame crosstie by placing it alongside the main expansion sheet and welding it to the bottom of the boiler tee. See Fig. W-7 N.

(i) Use of a cast steel tee fitted to the proper radius and attached to the boiler, with the leg of the tee machined with a ledge so as to fit the top edge of the expansion sheet; the lower end of the expansion sheet having machined fit to the frame crosstie. This method provides full bearing of the sheet, both top and bottom, and the sheet can be easily fitted. This looks like an exceptionally good method. See Fig. W-9.

(j) In some cases, in addition to the guide yoke expansion sheets, columns have been introduced between the guide yoke cross bar and the boiler, attached at the bottom to the guide yoke cross bar and at the top to a bracket on the boiler. This provides additional support between the guide yoke and the boiler, and also helps to support the guides. See Fig. G-4.

(k) Another group shows columns at the outer end of the guide yoke support, reaching from the guide yoke to brackets on the boiler. In one case they are attached to both the guide yoke and to the boiler, with flexible connections, which allow expansion. This is reported by the railroad using it as being very satisfactory, but they only report its introduction during the year 1926, so that there may be further developments in connection with this device. See Figs. G-14 and G-16.

The second group of troubles in connection with the guide yoke braces and waist sheet connections at the boiler is of more recent development. It is the cracking of the boiler at the ends of the tee irons or other connections between the sheet and the boiler, due either to weaving of the boiler or because these sheets on the larger boilers do not reach up as far as they do on smaller

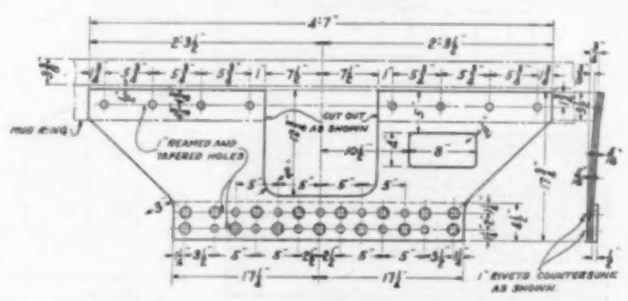


Fig. 7—Back End Connection Between Frame and Firebox, Design B-9

boilers. The earlier use of this form of attachment was in connection with smaller boilers.

To counteract this trouble, several improvements have been developed. They are shown on the different drawings, and are as follows:

(a) Cutting away of the bottom leg of the tee iron so as to make the flange more flexible where it comes in contact with the boiler. See Figs. W-1, W-2, W-3 and others.

(b) Introduction of a reinforcement in the form of a liner inside of the boiler shell at the top and of the tee iron or angle iron connected to the boiler. See Fig. G-10.

(c) Introduction of reinforcing pads on the outside of the boiler between the tee iron and the boiler, and extending beyond the ends of the tee iron at the top, Figs. W-11 N, W-14 and W-15, and, where the tee iron is not continuous, extending beyond the tee iron at the bottom also. See Figs. W-10, G-9, G-3, G-14 and G-15. In some cases the tee iron is fastened to the boiler shell as well as to this outside reinforcing plate. See Figs. W-14 and W-15. In other cases, it is fastened to the reinforcing plate only and the reinforcing plate is riveted to the boiler shell. This latter arrangement is very satisfactory. See Fig. G-9.

(d) Use has been made of inside reinforcing plates in the form of liners, extending around the bottom of the boiler. The tee iron connections are also sheared at an angle so that the line of contact will not coincide with an element of the cylindrical portion of the boiler shell, in this way, reducing the probability of longitudinal crack in the boiler.

See Fig. W-12. This arrangement is reported as satisfactory. Notice that the studs or rivets fastening the tee iron to the boiler pass all the way through both the shell and the inside lining. In connection with this lining, as well as in connection with the outside plates for reinforcement, it is to be noted that the ends of these reinforcing plates are not cut off straight across at the ends, but are tapered in such a way that the line of demarkation of the forces does not coincide with an element of the boiler shell.

(e) An arrangement reported as satisfactory is in connection with the fastening of the expansion sheet. A cast steel tee is attached directly to the boiler and riveted to the boiler, but without any lining. This is planed out to a radius to fit the boiler. A special feature of this device is the thinning at the outer ends, thus making it more flexible, and reducing the probability of sharp line of forces coinciding with an element of the boiler, and in this manner preventing a condition liable to develop a crack in the shell. A note on this drawing calls for a maximum thickness of ½ in. for the outer ends, while these ends are tapered so as to further reduce the probability of a sharp line of demarkation of the forces of reaction between this cast steel tee and the boiler shell. See Fig. W-9.

It is well here to call attention to the fact that on the group of illustrations marked "G" and "W," the following information is shown: Thickness of plate, depth of plate, distance from the center of cylinder to the expansion plate.

This is for the purpose of enabling those studying the construction of these devices to form an estimate as to just how much expansion movement they are expected to take care of.

At this point, attention is directed to the attachment of the front barrel ring of the boiler to the front or low-pressure engine on Mallet locomotives. In this connection, we have prepared three drawings, designed "M." The first, Fig. M-1, illustrates the connection between the floating casting attached to the barrel ring of the boiler with either bolts or rivets. Fig. M-2 shows a liner introduced at the extreme ends of this casting in order to reinforce the boiler at this point. Fig. M-3 shows this saddle casting attached to the boiler with a strap passing around the boiler. The casting bears against the reinforcing piece on the outside of the boiler and the reinforcing piece is riveted to the boiler. This serves a double purpose: To prevent wear of the boiler sheet; and also to distribute the forces of action between the boiler and the saddle at their extremities. In some cases, these saddle castings are held in the fore and aft position by being attached with rods to the cylinder. In some recent constructions, they are without this attachment, and so far, have given no trouble.

Furnace Bearers

The next general group is in connection with furnace bearers; we have segregated these into four different types.

We will refer first to the illustrations in the group marked "S," as they represent the earliest types and were used largely in connection with locomotives with narrow fireboxes, where they passed down between the frames, or where they passed between the driving wheels The arrangements shown in Figs. S-1 and S-2 are for locomotives where the firebox sits between the

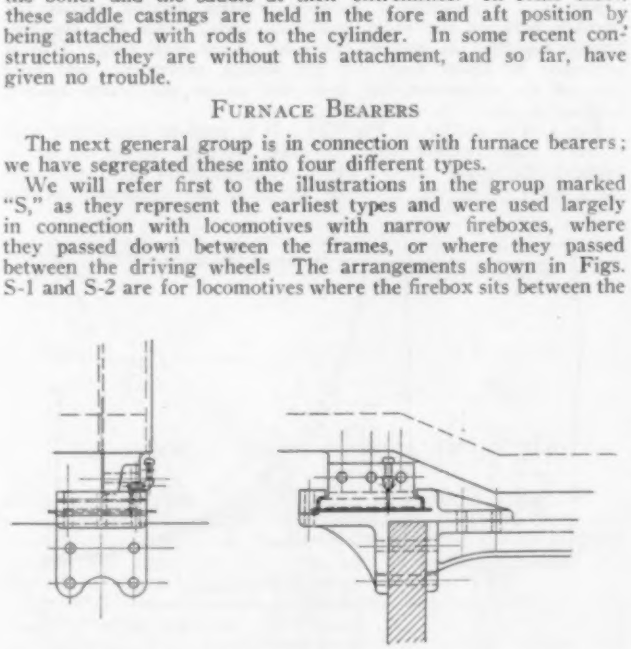


Fig. 8—Front Connection Between Frame and Firebox, Design F-11

frames. This arrangement was very serviceable during the period when locomotives of this type were constructed.

The link support shown in connection with Fig. S-3 came into use in connection with locomotive fireboxes that reach over the top of the frame, but not beyond the inside of the driving wheels. This attachment was used to a considerable extent at one time, but never proved entirely satisfactory, in that it does not brace the boiler and frame against relative lateral movement.

There are illustrated in Figs. S-4 to S-8, inclusive, details of a variety of designs representing boiler furnace bearers for locomotives where the furnace extends over the top of the frame, but not beyond the wheels. These various types illustrate the changes brought about by the differences in design of the other parts of the locomotive. All have in mind the same idea; viz., to furnish the longitudinal sliding movement on the frame; to confine the frame and boiler laterally in their proper relationship, and to tie the frame and boiler together. Various methods are used to take care of this situation. These can be readily understood by examination of the different drawings. The main feature seems to be to have a good wearing pad between the mud ring of the boiler and the frame so as not to wear either the mud ring or the frame; to provide a strong, serviceable attachment between the expansion pad and the firebox, so that it is not liable to come loose at the points where the parts are studded together. These devices have proved very serviceable, and if locomotives were built at the present time with fireboxes so narrow as not to reach beyond the driving wheels, devices of this type would undoubtedly be used generally, but at present, they are used only for locomotives that have been in service for a long time, or for small locomotives.

For the front furnace bearers, there are a variety of designs, both of the expansion plate and slide type.

Fig. F-1 represents an expansion plate between the bottom of

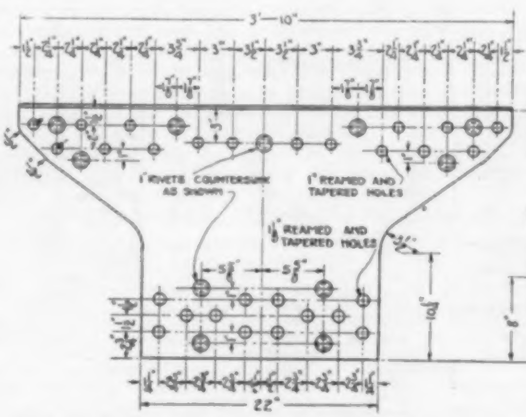


Fig. 9—Front Connection Between Frame and Firebox, Design F-12

the mud ring and a crosstie mounted on the frame. This is reported as unsatisfactory. It will apply only to light locomotives.

Fig. F-2 represents a sliding contact between the frame and a cross brace attached to the throat sheet, and resting on the frame. This serves to brace the two frames together, and prevents lateral movement between the firebox and the frames. This connection allows fore and aft movement. The detail does not show that the firebox is tied to the frame. This may have been done, but the illustration does not so indicate.

Fig. F-3 represents an early design of the expansion sheet at the front of the firebox; this is also reported as unsatisfactory. It is noted that it does not rest on the frame crosstie at the bottom, but the expansion sheet rests upon and is bolted to brackets, pointing inwardly from each frame toward the center—in this way making the expansion sheet itself a crosstie. The upper portion of this expansion sheet depends entirely upon the bolts to carry the load, and there are not many bolts.

The design shown in Fig. F-4 represents a decided effort to secure flexibility in the plates. It is reported as unsatisfactory.

Fig. F-5 represents a sliding contact between the locomotive frame and a shoe attached to the front end of the mud ring There is a wearing pad between the top of the frame and the bottom of the shoe to prevent wearing of the frame at this point.

Fig. F-6 represents a sliding pad at the front of the firebox, bearing on the frame, in connection with an expansion sheet of cast steel in the form of a truss, which is attached to the mud ring on the front side at the center and rests upon the bottom rail of the frame. The cast steel trussed expansion plate is not attached to the top rail of the frame but has feet bearing against the frame. This allows for the movement by the flexibility of this casting. Neither the pads on the top rail, nor the expansion sheet are arranged so as to tie the two locomotive frames together.

Fig. F-7 shows a flexible sheet supporting the front end of the firebox. This sheet is attached to the frame through two crossties one resting on the top of the bottom rail, and the other fastened underneath the bottom of the top rail. This sheet is attached to the crossties with bolts and rests against a prepared surface on the front end of the mud ring. This appears to be a reliable device, but is reported as unsatisfactory.

Fig. F-8 shows a shoe attached to the mud ring at the front and keyed to prevent relative lateral movement on the mud ring. Through this device the locomotive frames are tied together. Steel wearing plates are used between shoes and the frame. An oiling device is used.

Fig. F-9 represents a combination at the front end of the fire-

box, of a sliding device resting upon a frame casting, spreading from frame to frame, with an expansion plate which is fitted between ledges on both the cast steel frame crosstie and the bottom of the mud ring. This expansion plate is also bolted top and bottom. It is reported as being satisfactory. From appearances, it offers a substantial support and provides the very best attachment possible between the boiler and the frames.

Fig. F-10 illustrates the use of an expansion plate at the front end of the firebox. The bottom of the plate rests upon a prepared ledge on a cast steel crosstie, and the top of the sheet rests against a prepared ledge on the bottom side of the mud ring. In addition to these ledges, there are an ample number of bolts used to attach the sheet to both the mud ring and the frame crosstie casting. This is reported as very satisfactory.

Figs. F-11, F-13 and F-15 represent construction of front furnace bearers with sliding pads resting on top of castings which

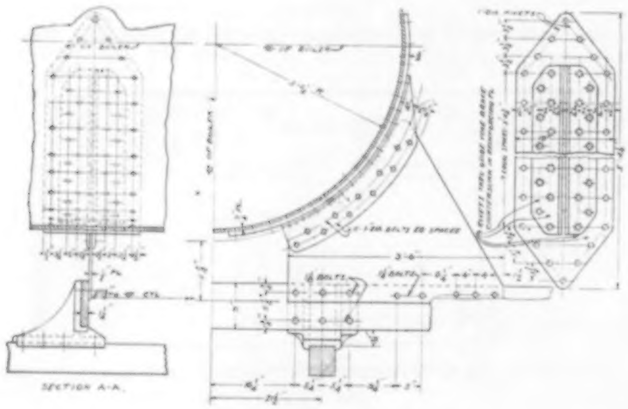


Fig. 10—Guide Brace, Design G-9

are attached to cross frame braces. Fig. F-11 shows an adjusting sheet to take up the vertical wear and also shows an oil cup. Both of these are good features. This design is reported as being very satisfactory.

Fig. F-12 shows an arrangement of an expansion sheet giving both great flexibility and large supporting capacity. These are obtained by using three thin sheets placed one against the other, giving the carrying capacity of a thick sheet, and the flexibility of a thin sheet. The arrangement is reported as being very satisfactory.

Fig. F-14 shows a front furnace bearer expansion sheet made from a thick sheet, left thick at both top and bottom sides to give large bearing surfaces for connections with both mud ring at the top, and frame braces at the bottom. The center portion of the sheet is thinned to allow flexibility. This is better than a riveted reinforcement at the edges, but is much more expensive. This form of construction is applicable to any of the expansion sheets.

Fig. F-16 is a similar slide to that shown in Figs. F-11, F-13 and F-15, but without any frame crosstie. This arrangement is reported as being satisfactory.

The back furnace bearers are shown in a group of sketches, marked "B." Fig. B-1 shows a device designed in the form of a backhead brace that was used for light engines, in order to support the back end of the frame when jacking. Expansion is arranged for by the use of a slotted hole in the foot of this brace.

Fig. B-2 shows the rear furnace bearer in the form of a knee brace studded to the back end of the boiler with the extending flange resting on the foot plate.

Fig. B-3 shows a sliding shoe. This is used in connection with the back end of the firebox when it overreaches the frames. It shows the mud rings set well above the engine frame, and the shoe carried on a bracket attached to the frames to fill the distance between the shoe and the frame. The brackets on the two frames are tied together with a deep plate, which plate also serves as a support for the other parts. This is a very satisfactory device.

Fig. B-4 shows an arrangement of a single sheet which is flexible in the direction of the boiler expansion. It shows the top portion of the sheet fitted against the bottom of the mud ring, and the bottom portion of the sheet fitted on a ledge at the front end of the foot plate and fastened both top and bottom with bolts.

Fig. B-5 shows a link connection fastened on the backhead of the boiler. This link is attached to a bracket with a pin, the bearing surface of which falls outside of the locomotive frame. This would not seem to be a very stable device. It furnishes no more lateral confinement of the rear end of the boiler than does the link placed on the side of the boiler.

Fig. B-6 shows an arrangement of expansion sheets cut in three pieces across the engine, the outside parts reacting against the back spring hanger brackets.

Fig. B-7 shows a sliding arrangement used in connection with the back corner of a narrow firebox. This arrangement is a very good one in that it furnishes all the needed support laterally and vertically, and, at the same time, allows for the necessary longitudinal boiler expansion. It also furnishes the desirable wearing pad between the furnace bearer and the engine frame, and a secure attachment to the mud ring, offering resistance to any lateral movement.

Fig. B-8 and B-10 show sliding brackets for the back end. These are similar to a number of those that have been shown in connection with the front end of the firebox. These can rest directly on the back foot plate, or on the special pads cast on the rear cradle casting of the engine frame.

Fig. B-9 shows an arrangement of expansion sheets, two being placed together in such a way as to get ample support with great flexibility. This arrangement is reported as being very satisfactory.

Fig. B-11 shows a very wide expansion sheet at the back end. This expansion sheet is reinforced, both top and bottom, with an extra thickness of plates. This brings about additional bearing on both at the top and bottom, thus taking care of the bolt and rivet bearing and shearing. This is reported as a very satisfactory arrangement.

Furnace Crossties and Grate Bar Supports

Fig. C-1 represents a furnace crosstie and grate bar support which is attached to the bottom of the mud ring, between the front and back ends, and is also rigidly attached to the frames. The arrangement is such that it makes necessary the springing of the parts in order to take up the boiler expansion.

Fig. C-2 represents a furnace crosstie located across the furnace between the front and back ends. This ties the two frames together, as well as the sides of the mud ring. This is arranged to allow fore and aft sliding movement, and take care of the expansion, but does not secure the frame against separation from the mud ring.

Fig. C-3 is similar to Fig. C-1. It is used in connection with a very wide firebox, and its main purpose seems to be to support the grate bars. The arrangement is such that the parts have to spring in order to allow the expansion of the

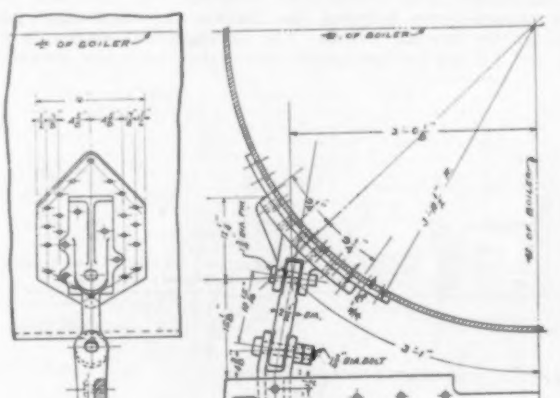


Fig. 11—Guide Brace, Design G-14

boiler on the frame. It serves, however, both as a firebox crosstie and as a frame crosstie.

In review of the various methods employed as shown in the report for securing the boiler to the locomotive frame, the following general recommendations are made:

1—Waist sheets should be rigidly attached to the boiler shell.

2—Waist sheets and other connections between the frames and boilers of locomotives should be provided with a reinforcing liner interposed between the angle or "T" iron and the boiler shell.

3—Furnace bearers between mud ring and frame, when used, should be of sliding type and provided with bronze liners.

4—Front and back of firebox be supported with a plate as deep as possible to provide flexibility. Top and bottom of plate to be reinforced to provide ample bearing area for bolts.

5—Where possible, supporting sheets should be machined to fit in a shoulder on the part to which attached to relieve stresses on the bolts.

The report of the subcommittee on Provision for Expansion of Locomotive Boilers on the Frames is signed by A. Kearney (chairman), W. L. Bean and H. H. Lanning.

Exhaust Steam Injectors

[The subcommittee, consisting of G. H. Emerson (chairman), H. A. Hoke and R. M. Brown, recommended that the subject be continued for further report.—Editor]

Boiler Pressures Higher Than 200 lb.

During the last few years, opinion has been gradually crystallizing in favor of higher boiler pressures for steam locomotives. From present activities, we appear to be entering an era of thermo-dynamic improvement, similar to that brought about by the introduction of superheating, some 20 or 25 years ago, and as the latter had its greatest impetus from German engineers, so, at the present moment, it appears that the Germans are just now taking the lead in the development of ultra locomotive boiler pressures, closely followed by the Swiss.

The outstanding advantage of high pressure; namely, extra available heat energy from a given fuel, will continue to invite the activities of engineers working on different lines of thought, which will advance development toward the ultimate goal of what we consider today as ultra-pressure. There are greater difficulties to overcome in the development of high steam pressures than in the development of high steam temperatures by superheating. On the other hand, the incentive for economy today is much greater than 25 years ago.

While no serious attempts have been made in this country to use ultra-high pressures, there are a large number of locomotives running with the lower range of high pressures. There are somewhat over 1,000 American locomotives using 250 lb. pressure, and others being constructed. As a whole, there are no distinctive departures from convention in the design of these locomotives, excepting that they are as a rule arranged for limited cutoff—usually 50 or 60 per cent maximum.

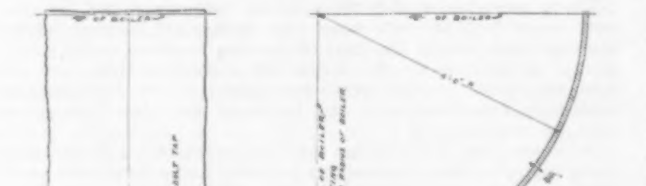


Fig. 12—Waist Sheet Connection, Design W-9

There are also a number of locomotives operating on one road in which a boiler pressure of 265 lb. is used. These are equipped with McClelland water-tube firebox boilers, but in other respects of conventional design.

The use of pressures above 265 lb. is apparently confined to the following examples: The Delaware & Hudson "Horatio Allen," using 350 lb. boiler pressure; the "John B. Jervis," of the D. & H., which will use 400 lb. boiler pressure, and the Baldwin Locomotive Works No. 60,000, which uses 350 lb. steam pressure. Data from the Altoona test plant is now published and shows this locomotive as having produced greater fuel economy than any other locomotive tested in this plant, and service tests on several prominent roads appear to sustain these figures.

As a result of the use of higher pressures, limited cutoff and compounding, locomotives of the types mentioned show favorable reduction in steam consumption; in most instances an increase in tractive effort.

Several other roads are at present favorably considering new locomotive design including steam pressures from 400 to 500 lb.

European Developments

European experiments and developments in high-pressure locomotives embrace a variety of ideas, some of which are a distinct departure from present accepted practices. Particularly are European engineers and railway men interested in pressures in excess of those under present consideration in America.

Several high pressure locomotives have been constructed and are under test on European railways. Some of these have interesting possibilities. As no detailed information is available on most of this experimental equipment, the descriptions contained herewith are necessarily brief.

*The "Schmidt-Henschel two-pressure" locomotive** is an unusual unit which was constructed at the Henschel-Sohn works at Cassel, Germany. It is now undergoing test operation on the German State Railways.

Three pressures are produced in the boiler, although but two, the 850 lb. and the 200 lb., are working pressures. The 850 lb. pressure is superheated to about 716 deg. F. and worked expansively in a center high-pressure cylinder. It is exhausted at about 200 lb. pressure, mixed and reheated with fresh superheated steam from the low pressure part of the boiler and then expanded in the two low-pressure outside cylinders. The low-pressure steam is highly superheated so that the resultant temperature, after mixing with the steam which has been cooled by cylinder expansion, is at a temperature of about 660 deg. F., as it goes to the low-pressure cylinders. The final exhaust is through the stack in the usual manner. A feedwater heater and sediment separating arrangement is provided for the low-pressure boiler, and feedwater for the high working pressure drum is pumped from the low-pressure boiler.

Some of the advantages expected of this design are as follows:

1—Freedom from scale in the firebox portion of the boiler, because of the use of distilled water; the absence of fire contact surfaces and the use of clean water in the drum portion; and the lower pressure and sediment separation arrangement in the low-pressure part of the boiler.

2—Freedom from cylinder condensation because of the reheating effect of the highly superheated low-pressure steam upon the expanded steam with which it is mixed as it passes to the low-pressure cylinders.

3—Relatively high overall economy as a result of the inherent economy of the high-pressure steam, reheating and compounding, and the efficient heat flow from flame and hot gases to the water.

This locomotive was converted from an ordinary three-cylinder locomotive developing originally 1,800 hp. In its present high-pressure form the output is 2,000 hp. No operating data indicating the efficiency obtained is as yet available, but your committee is in correspondence with Henschel & Sohn, also the German State Railways, to develop this data. We have learned in a general way that the results of preliminary tests are very encouraging.

Buchli Locomotive—Another development worthy of attention is a high-pressure locomotive designed by Dr. Buchli and built by the Swiss Locomotive Works, Winterthur, Switzerland. The boiler is a water-tube type developing 800 lb. direct pressure and is equipped with feedwater heater, superheater and air preheater.

The engine is very unusual, being a small high speed three-cylinder, horizontal, uniflow type with poppet admission valves—the cylinders are only 10 in. diameter. All parts are enclosed and run in oil, including filter, force-feed and oil cooler. It is geared to the drive wheels with two to one ratio gears and, being a complete unit, can be removed as such from the locomotive. The exhaust pipes or passages from each of the three cylinders terminate in a "Y" formation so that each exhaust impulse will produce an ejector effect on the two other cylinders and thus reduce the effective back pressure.

Some advantages Dr. Buchli is striving for, and from indications of tests may attain, are:

1—High overall efficiency.

2—Low first cost, and reduction of wear and cost of servicing through use of small light weight reciprocating parts.

3—Ability to operate at a high cutoff point. It will start loads at 27 per cent, shows good indicator cards at from 9 to 12 per cent, and operates easily at 5 per cent cutoff.

4—Elimination of dynamic augment as counterbalancing of revolving parts only required.

5—Low adhesion factor because of the twelve impulses per revolution of drive wheels.

In preliminary tests this locomotive is reputed as showing a net efficiency of 11 per cent and a smooth performance mechanically. The Buchli design as a whole represents a marked departure from conventional design, both as to boiler and machinery, and illustrates the boldness of European locomotive designers.

Maffei Turbine Locomotive—Still another development of a different character is the Maffei turbine locomotive built by J. A. Maffei of Munich, Germany, for the German State Railways. This locomotive develops 2,500 hp. and was designed to haul heavy express trains at an average speed of 62 m.p.h. The design is particularly adapted for high speed.

The turbine is mounted at the front and is geared to a jack-shaft from which the final drive to three pairs of drivers is by side rods. The exhaust steam is condensed in two surface type

*For a description of this locomotive see the *Railway Age* for June 26, 1926, page 1969.

condensers mounted, one on each side of boiler, below running boards, the water for condensers being air cooled in the water cooler portion of the tender. A turbine-driven fan creates the necessary draft for ejection of waste furnace gases., Mechanical draft becomes a simpler problem when handling the waste gases only. Other auxiliaries are likewise turbine driven. Of particular interest is the use of 324 lb. pressure in the boiler of ordinary stayed sheet firebox type.

This locomotive is a highly advanced example of engineering skill and may indicate one of the several means toward attaining high economies with steam locomotives. Advantages anticipated from this design are:

1—High overall economy as a result of high steam pressure, turbine drive and condensing. The builders expect an efficiency at the turbine jackshaft of 15.6 per cent at a speed of 43.5 m.p.h.
2—Lighter total weight per horsepower, these particular locomotives being 18,000 lb. lighter than corresponding lower pressure reciprocating types of equal output.
3—Elimination of dynamic augment as the counterbalancing of the side rods only is required.
4—Low adhesive factor as a result of the uniform torque.
5—Freedom from scale formation because of the condensing.
6—Quietness of operation.

Ljungstrom Turbine Locomotive—Another locomotive using pressures higher than ordinary in a boiler of conventional type is the Ljungstrom turbo-locomotive. This is a Swedish design, the first being constructed in Sweden for the railways of that country and later, one in England for use in that country. The steam is produced at a pressure of 285 lb. in a boiler of conventional construction, mounted upon a framing and wheels forming the "boiler vehicle" or forward part of the locomotive, but contributing none to the adhesive weight. The turbine, which is of 2,000 hp. capacity, is mounted upon the tender or rear portion of the locomotive and geared to the wheels thereof. The advantages and disadvantages of this type of locomotive correspond practically to those mentioned in the description of the Maffei turbine locomotive, the variation in design being in the details rather than in general principles.

Comparative performance tests were made with turbo and reciprocating types of locomotives, figures given being pounds of coal per 1,000 ton miles:

Turbo locomotive—highest, 45.5 lb.; lowest, 39.1 lb.
Reciprocating locomotive—highest, 130 lb.; lowest, 82.9 lb.

Comparing the average turbo performance with the lowest for the reciprocating type shows a saving in coal consumption of 49 per cent. The comparison would be a less favorable one if made with some of the latest examples of American locomotives.

Other forms of turbo-locomotives, such as the Krupp and Zoelly designs, which are to be adapted to the use of high pressures are under development and test.

Krupp Turbine Locomotive—This locomotive as now being constructed is to have a maximum output of 2,500 hp. and use a pressure of 854 lb. The boiler is constructed similar to the Thorncroft-Schultz marine boiler, that is, with top and bottom drums connected with water tubes. Construction of this locomotive will not be completed until tests of the present Krupp low pressure turbo-locomotives are completed.

In consideration of turbine locomotives which seem particularly well adapted to the use of high steam pressures, some factors must be considered which counteract to an extent the advantages derived therefrom. They at present seem to be adapted principally to high speed passenger service, are relatively complex in design and construction, and the first cost is much greater than conventional designs. In Germany this increase in cost has been found to be about 80 per cent, although development may reduce that figure somewhat. If the economies expected are realized, the first cost may become of secondary importance.

Loeffler Locomotive—Two locomotives of the piston type are being built by the Berlin Machine Builders to the designs of Prof. Loeffler. These locomotives are reported by Dr. Wagner of the German State Railways to have characteristics about as follows: 2,500 hp.; boiler pressure, 1,422 lb. The boiler consists of a high-pressure drum containing water and a tube type superheater.

Saturated steam is pumped from the drum through the superheater coils, 25 per cent of the steam going to the engine cylinders and the balance returning to the boiler drum, where it is injected into the water. Here it gives up its residual heat to the water; generating saturated steam which continues on through the cycle. The steam used in the cylinders after performing its work is condensed and the water returned to the boiler. Hot combustion gases come in contact only with coils or boiler tubes containing steam. A fuel economy of 45 per cent is anticipated, compared with usual conventional design.

In addition to the examples cited, other high-pressure experimental locomotives are under construction, but concerning which little information is at present available.

Present and Future Locomotive Developments

There are greater difficulties to be encountered in the construction of high-pressure water-tube boilers and their associated working apparatus in the case of locomotives than in stationary plants, particularly in the matter of space limitation, yet undoubtedly some of the knowledge gained in the high-pressure stationary experimentation can be made use of in connection with locomotive work.

In connection with design and construction of locomotives using high-pressure steam—there are two major problems which must be given due consideration and study. They are: First, the means of producing the high-pressure steam, viz.; the boiler and its various associated appurtenances; and second, the apparatus for working or using the steam, whether piston type engine or turbine, and its various associated or connected parts. It is necessary that we feel our way, try various ideas and select those that survive through their natural fitness.

There is one requirement which must not be overlooked—that of reliability. The ability to move the traffic over the road at all times and under all conditions, good or adverse.

The fire-tube boiler now in general use is reliable, compact, low in first cost, has great evaporative capacity in relation to space occupied; and in addition it has the advantage of great energy storage capacity which is of value on account of the sudden fluctuation of demand upon the motive unit.

Table I—Tabulation and Specifications of Oil-Electric Locomotives

Country	No.	Locomotive builder	Owner	Engine builder	Electric builder	Hp.	Total weight	Weight per Hp., Eng. only	Weight per Hp., total	Cylinders No. and Size, in.	Cycle	Fuel injection	R.p.m. engine	Wheel arrangement	Date in service
USA	1	A.L.Co....	C.R.R.N.J..	I. R......	G. E.	300	120M	66.7	400	6-10 x15	4	Solid	600	4-4	10-22-25
USA	1	A.L.Co....	B. & O....	I. R......	G. E.	300	120M	56.7	400	6-10 x15	4	Solid	600	4-4	12-26-25
USA	1	A.L.Co....	L. V.	I. R......	G. F.	300	120M	56.7	400	6-10 x15	4	Solid	600	4-4	1- 7-26
USA	1	A.L.Co....	C. & N.W..	I. R......	G. E.	300	120M	56.7	400	6-10 x15	4	Solid	600	4-4	5- 4-26
USA	1	A.L.Co....	Erie	I. R......	G. E.	300	120M	56.7	400	6-10 x15	4	Solid	600	4-4	5-25-26
USA	1	A.L.Co....	Reading....	I. R......	G. E.	300	120M	56.7	400	6-10 x15	4	Solid	600	4-4	6- 1-26
USA	1	A.L.Co....	D. L. & W.	I. R......	G. E.	300	120M	56.7	400	6-10 x15	4	Solid	600	4-4	6-23-26
USA	1	A.L.Co....	D. L. & W.	I. R......	G. E.	300	120M	56.7	400	6-10 x15	4	Solid	600	4-4	7- 1-26
USA	1	A.L.Co....	C. & N. W.	I. R......	G. E.	300	120M	56.7	400	6-10 x15	4	Solid	600	4-4	10-19-26
USA	1	A.L.Co....	C. & N. W.	I. R......	G. E.	300	120M	56.7	400	6-10 x15	4	Solid	600	4-4	4-19-27
USA	1	"Utah Copper"		....	G. E.	300	120M	56.7	400	6-10 x15	4	Solid	600	4-4	7-23-26
USA	1	A.L.Co....	I. R.	I. R......	G. F.	300	120M	56.7	400	6-10 x15	4	Solid	600	4-4	9-24-26
USA	1	Brill.......	L. V.	McI.-S.....	G. E.	300	52M	90.0	507	12- 8 x 9½	4	Air	500	4-4	U. C.
USA	1	A.L.Co....	L. I.	I. R......	G. E.	600	200M	56.7	333	12-10 x12	4	Solid	600	4-4	12-22-25
USA	1	A.L.Co....	Red Riv...	I. R......	G. E.	600	200M	56.7	333	12-10 x12	4	Solid	600	4-4	8-17-26
USA	1	A.L.Co....	G. N.	I. R......	G. E.	600	200M	56.7	333	12-10 x12	4	Solid	600	4-4	9-24-26
USA	1	A.L.Co....	L. I.	I. R......	G. E.	600	200M	56.7	333	12-10 x12	4	Solid	600	4-4	U. C.
USA	1	A.L.Co....	N. Y. C...	I. R......	G. E	300	250M	56.7	833*	6-10 x12	4	Solid	600	4-4	U. C.
USA	1	A.L.Co....	N. Y. C...	I. R......	G. E.	750	290M	60.0	388	6-14½x16	4	Solid	500	4-4	U. C.
USA	1	A.L.Co....	N. Y. C...	McI.-S. ...	G. E.	880	330M	91.0	375	12-14 x18	4	Air	300	4-4	U. C.
USA	3	P.R.R.....	P. R. R....	Bessem ...	West.	500	130M	40.0	260	8- 8½x12	4	Solid	800	0-4-0	U. C.
USA	9	A.L.Co....	Stock	I. R......	G. E.	300	120M	56.7	400	6-10 x12	4	Solid	600	4-4	In Stock
USA	2	A.L.Co....	Stock	I. R......	G. E.	600	200M	56.7	400	12-10 x12	4	Solid	600	4-4	In Stock
USA	1	Bald.......	Exp.	Knuds	West.	1000	275M	56.7	275	12- 9¾x13½	2	Solid	450	6-6	1925
Germ.	1	Lormon-Hohenz..	Russia	M.A.N.....	Brown-Boveri	1000	262,400	60.7	262	6-17.7x16.5	4	Air	450	2-10-2	1925
Germ.	1	Krupp.....	B. & M....	M.A.N.....	Krupp	1400	314M	71.5	225	6-16.9x16,9	4	Solid	470	4- 8-4	U. C.
Austria	2	Austria State R. R. Grazer			....	200	......	....	....	....	4	Solid	....	......	U. C.
Italy	1	Fiat.......	Colobra ...	Fiat	Brown-Boveri	440	110M	....	250	6	2	Air	500	4-4	1925
Russia	1	Hockel.....	Russia	Vickers ...	Elec.	1000	396,840	....	397	10	....	Solid	395	2-20-2	1925

* Oil-electric storage battery switch engine. "U. C." means under construction.

It is, however, limited somewhat by reason of the excessive thickness and weight of sheets required for high pressure, this being the reason for adoption of water-tube principle in most of the recent experimental units. The general use of higher boiler pressures which seems inevitable spells the doom of the boiler with staybolted surfaces; and, with our staybolt troubles, we should not be sorry to see it pass. The Brotan, McClellan, Muhlfeld, and other boilers are indicative of the trend toward water-tube. These boilers operate under pressures of 250 to 400 lb. Higher pressures than these will compel a still further application of the water-tube boiler principles to the extent of displacing the shell and fire tubes.

The use of alloy steels will assist in the reduction of this limitation as is apparent by the use of nickel steel on some Canadian Pacific locomotives whereby it was possible to increase the steam pressure from 200 to 250 lb. with no increase in the thickness of the boiler shell, firebox sheets and diameter of stays.

Controversial ideas have been expressed as to the maximum pressure practical to use in the ordinary stayed type of firebox, these centering largely on a pressure of 250 lb. as a limit. Upsetting somewhat this arbitrary limit, it is noted that two European locomotives previously described are using pressures of 285 lb., and 324 lb., in boilers of ordinary construction. These are the Ljungstrom and Maffei turbo-locomotives. These are of course smaller than prevailing American equipment, and the pressures indicated are lower than those now contemplated by many designers.

In connection with the construction of water-tube boilers for locomotives, some difficulties may be encountered in keeping tube connections tight, and it is more difficult to construct a rigid unit such as is required in locomotive work, than is the case with conventional type of boiler. Some loss in heat storage capacity will result from the reduced volume of water under pressure, but this may be compensated for to an extent by more flexible steaming capacity.

One difficulty which may present serious aspects in connection with the high-pressure boiler lies in the very general use of untreated water. With the high temperature used this may be serious and washing and cleaning may become burdensome. Boilers so designed as to obtain a rapid circulation will avoid much of this difficulty. The use of condensing as on turbo-locomotives would, if practical to apply to our large units, practically solve this difficulty. Experience with the Brotan, McClellan and Muhlfeld water-tube firebox indicates that scale formation, cleaning and inspection, does not present the difficulties that were expected and it is possible that with reasonably good water, difficulties along this line will be minimized.

Many conceivable arrangements may be suggested for the working or expansion cycle of a high-pressure locomotive. The use of high-pressure steam and multicylinder design tends to improve the construction through the use of smaller parts and the greater possibilities for work production of high-pressure steam. The multicylinder construction reduces the necessary adhesion weight on account of more uniform torque action, this approaching to a certain extent that quality which is quite characteristic of the turbine.

Turbine locomotives have some interesting possibilities, although those built so far in Europe do not exceed 2,500 hp., being of smaller capacity than would be required for general service in America. The designing of a condenser for turbine locomotives of 4,000 or 5,000 hp. might present quite a problem.

Proper superheating will, of course, be important, but rather than add a high initial superheat, it seems preferable to use a moderate initial superheat, expand the steam in more than one stage, and reheat between stages. Losses from condensation would be reduced and the superheating between expansion stages would be effective because of the greater temperature difference at that time between the steam and the furnace gases.

Your committee does not feel that the present-day development of the higher pressures offers opportunity to suggest any recommendations, and desires this paper to be accepted as an outline report.

The report of the subcommittee on High Boiler Pressures is signed by A. H. Felters, (chairman), W. I. Cantley, H. M. Warden and M. F. Cox.

Oil-Electric Locomotives

The committee report covers the development of design of oil-electric locomotives; the status of application of the oil-electric locomotive to railroad service, and operating costs.

Recommendations for Future Work

The following subjects are recommended for future work: Continue study and make report on development and use of the oil-electric locomotive in railroad service; continue to collect operating information and, if practical, analyze operation costs, and include oil-engined locomotives whose transmission is other than electric, such as the electro-magnetic clutch proposed for the B. & M.

Development in Design

The development in designs of oil engines for locomotive work in railroad service is little changed from last year. The desire for this type of prime mover has been largely inspired by demand for

a. Smokeless, self-contained motive power unit.
b. Lower operating costs for switching service.

The development of the oil-electric in light high-speed units, enough to compete with steam locomotives for general road service, in America, has not yet been effected.

Status of Application

Table I gives a tabulation and brief specifications of the oil-electric locomotives referred to below. The locomotives for the New York Central are expected to be delivered during the latter half of 1927. The oil engines for the Pennsylvania Railroad have not been delivered to date. The oil engine for the B. & M., which is an electric-magnetic clutch transmission, is under construction in Germany at the Krupp Works at Essen.

Oil-Electric Locomotives in the United States

Figs. 1 and 2 show the 300 and 600 hp. oil-electric locomotives built by the Ingersoll-Rand Company, American Locomotive Company and the General Electric Company.

Operating Costs

The tables cover certain operating costs, over a limited test period as taken from the builders' records and files. These figures cover present hard coal switch engines without modern auxiliaries such as superheaters, feedwater heaters or other devices which may have affected the economic operation. The load factor is the ratio of the actual output to the maximum rating and is expressed in the case of the oil-electric locomotive as the ratio of the actual kilowatt output to the maximum kilowatt rating.

In order to ascertain certain information and operating costs of the oil-electric locomotives in railroad service, over an extended period, a questionnaire was addressed to the chief operating officers of four railroads having this type of power in service over a period of at least one year. During the year 1926, six more railroads and two industrial firms have placed oil-electric locomotives in service and next year their names will be added to the list for the mailing of the questionnaire.

Abstracts of the replies received are presented in table VI. No attempt has been made to analyze these costs at this time owing to the limited number in service over such a short period, and the character of the service to which some of these units have been assigned which makes it difficult to obtain similar comparison of steam locomotives in either yard or other regular railroad service.

Table II—Operating Ratios Oil-Electric Locomotives

The following tabulation gives the kilowatt output per gallon and the ratio of lubricating oil to fuel for a number of records on oil and gas electric locomotives, September, 1925, to April, 1926:

	Hour service	Load factor, per cent	K.w.hr. per gal.	Ratio lub./fuel, per cent
1. 60-ton, road A September 1-2, 1925	16	28	8	2.7
2. 60-ton, road A Nov., Dec., Jan., 1925, 1926	1052	10.5	6.02	2.1
3. 60-ton, road A February, 1926	293	8.4	6.06	2.95
4. 60-ton road B January, 1926	162	8.6	5.5	3.6
5. 60-ton, road B February, 1926	214	8.2	5.8	3.3
6. 60-ton, road C January, 1926	394	8.2	6.15	2.6
7. 60-ton, road C February, 1926	365	7.	5.6	2.75
8. 100-ton, road D December 15, 1925	40	33	8.05	1.
9. 100-ton, road D February 15-27, 1926	220	15.1	7.5	1.2
10. 45-ton gas electric—1925	2511	23.7	5.85	2.95

Table III—Comparative Operations Oil-Electric vs. Steam

	December Oil-Elec. 1925	Steam 1924
Number of days	24	24
Hours of locomotive service	347	297
Operating fuel consuming hours	318	297
Fuel oil used—gallons	1038	...
Diesel lubricating oil used—gallons	25	...
Gasoline used—gallons	5	...
Engine oil used—gallons	5	5
Valve oil used—gallons	10	5

(Continued on page 1892)

(*Continued from page* 1891)

	December Oil.-Elec. 1925	Steam 1924
Star cup grease used—pounds	1	...
Kilowatt hours generated	6614	...
Coal used—tons	...	41
Number of floats handled—in	57	47
Number of floats handled—out	57	46
Number of floats handled—total	114	93
Tons handled off floats	38889	31040
Tons handled on floats	22667	19453
Tons handled total floats	51556	50493
(Includes tare weight of cars)		
Number of cars handled—in	947	775
Number of cars handled—out	943	765
Number of cars handled—total	1690	1531
Daily Average		
Hours of locomotive service	14.5	12.4
Operating fuel consuming hours	13.3	12.4
Fuel oil used—gallons	43.2	...
Diesel lubricating oil used—gallons	1.04	...
Gasoline	Neg.	...
Coal used—tons	...	1.7
Kilowatt hours generated	275	...
Number of floats handled	4.75	3.87
Number of cars handled	79	64
Number of tons handled	2565	2104
Cost of fuel, oil, coal, etc.—total	$2.98	$14.56
Operating Hourly Average Cost		
Fuel, oil, coal, water, etc.	$.228	$1.18
Per car on and off floats	.038	.228
Per ton on and off floats	.0011	.0069
Cost per KW hour	.0109	....
Cost of Operation		
Fuel oil at 5¢ per gallon	$51.90	...
Diesel engine lubricating oil at 53¢ gal.	13.25	...
Gasoline at 14.5¢ gallon	.72	...
Water at $1.00 per 1,000 cubic feet	.03	$28.37
Engine oil, .262 per gallon	1.31	1.31
Valve oil, .53 per gallon	5.30	2.65
Star cup grease, .07 per pound	.07	...
Coal cost, 7.15 per ton	...	293.15
Coal cost handling	...	24.00
Total cost of fuel, coal, oil, etc.	72.58	349.46

Table IV—Comparative Operations Oil-Electric vs. Steam

	January Oil-Elec. 1926	Steam 1925
Number of days	25	27
Hours of locomotive service	407	315
Operating fuel consuming hours	380	315
Fuel oil used—gallons	1212	...
Diesel lubricating oil used—gallons	25	...
Gasoline oil used—gallons	5	...
Valve oil used—gallons	10	5
Star cup grease used—pounds	1	...
Kilowatt hours generated	7025	...
Coal used—tons	...	48
Number of floats handled—in	57	41
Number of floats handled—out	57	44
Number of floats handled—total	114	81
Engine oil used—gallons	5	5
Tons handled off floats	39902	26864
Tons handled on floats	22892	16767
Tons handled—total	62794	43641
(Includes tare weight of cars)		
Number of cars handled—in	942	672
Number of cars handled—out	949	650
Number of cars handled—total	1891	1322
Daily Average		
Hours of locomotive service	16.2	11.7
Operating fuel consuming hours	15.2	11.7
Fuel oil used—gallons	48	...
Diesel lubricating oil used—gallons	1	...
Gasoline	Neg.	...
Coal used—tons	...	1.8
Kilowatt hours generated	281	...
Number of floats handled	4.56	3
Number of cars handled	76	49
Number of tons handled	2511	1616
Cost of fuel, oil, etc.	3.35	14.91
Operating Hourly Average Cost		
Fuel, oils, coal, etc.	$.213	$1.27
Per car on and off float	.043	.304
Per ton on and off float	.0013	.0092
Cost per KW hour	.0115	.....
Cost of Operation		
Fuel oil, 5¢ per gallon	$60.60	.....
Diesel engine lubricating oil, 53c per gal.	13.25	.....
Gasoline, 14.5¢ per gallon	.72	.....
Water, $1.00 per 1,000 cubic feet	.03	$28.36
Engine oil, .262 per gallon	1.31	1.31
Valve oil, .53 per gallon	5.30	2.65
Star cup grease, .07 per pound	.07	.....
Coal, 7.15 per ton	...	343.20
Coal handling	...	27.00
Total cost of fuel, etc.	81.28	402.52

Table V—Comparative Operations Oil-Electric vs. Steam

	February Oil-Elec. 1926	Steam 1925
Number of days	24	23
Hours locomotive service	312	295
Operating fuel consuming hours	293	295
Fuel oil used—gallons	812	...
Diesel lubricating oil used—gal.	24	...
Gasoline	5	...

	December Oil.-Elec. 1925	Steam 1924
Engine	5	5
Valve	10	5
Star cup grease	1	...
Kilowatt hours generated	4921	...
Coal used—tons	...	40
Number of floats—in	41	39
Number of floats—out	41	39
Number of floats—total	82	78
Number of cars off float	674	655
Number of cars on float	673	631
Number of cars—total	1347	1286
Tons handled off floats	26285	27764
Tons handled on floats	16061	16031
Tons handled total floats	44346	43795
(Includes tare weight of cars)		
Cost of Operation		
Fuel oil, 5¢ per gallon	$40.60	...
Diesel engine lubricating oil, 54¢ per gal.	12.96	...
Gasoline, 14½¢ per gallon	.72	...
Water, $1.00 per 1,000 cubic feet	.03	$26.86
Engine oil, .252 per gallon	1.31	1.31
Valve oil, .53 per gallon	5.30	2.65
Star cup grease, .07 per pound	.07	...
Coal, $7.15 per ton	...	286.00
Coal handling	...	24.00
Total cost of fuel, etc.	60.99	340.84
Daily Average		
Hours of locomotive service	13	12.8
Operating fuel consuming hours	12	12.8
Fuel oil used—gallons	28	...
Diesel lubricating oil used—gal.	1	...
Gasoline	Neg.	...
Coal used—tons	...	1.7
Kilowatt hours generated	205	...
Number of floats handled	3.4	3.4
Number of cars handled	56.1	55.9
Number of tons handled	1947	1904
Cost of fuel oil, etc.	$2.54	$14.82
Operating Hourly Average Cost		
Fuel oil, coal, etc.	.208	1.15
Per car on and off floats	.045	.265
Per ton on and off floats	.0016	.0078
Cost per Kil. hour	.0124	....

Table VI—Abstract of Replies from Four Railroads in Answer to Questionnaire

	Railroad A	Railroad B	Railroad C	Railroad D
Class of service (switch, flat yard, hump or road)	float and flat yard	small yard flat	small yard flat	switch
Date placed in service	10-20-25	Jan. 1926	Jan. 1926	Feb. 1926
Was purchase made in interest of smoke abatement or interest of lower operating costs?	smoke abatement	to comply with Act of Legislature	to comply with State Law	both
Load factor	unknown	10%	....	7.9
Total mileage	28842	15612	21774	29376
Total engine hours	4807	2602	3629	9792
Availability—% serviceable days	100	85	....	78
Reliability—miles per failure	7210	7806	....	2260
Estimated life of power plant	20	10	....	....
Estimated life of transmission	20	10	....	25
Rate of depreciation—per cent	3	3½	12	....
Average No. cars handled per day	unknown	61	26	480
Average No. tons handled per day	unknown	no inf.	no inf.	no inf.
Average No. 1,000 g.t.m. handled per day	unknown	no inf.	no inf.	no inf.
Costs per hour (average for total time in service)				
Fuel	.1836	.267	.212	0.29
Lubrication	.1032	.055	.031	0.07
Supplies	.0174	.0158	.027	no data
Cleaning and housing	.....	.050	.410	no data
Running repairs	.726	.2425	.518	no data
Shop repairs	.....	.289	......	no data
Depreciation and interest	1.14	2.22	2.070	unable to answer
Total cost per mile or hour	2.172	3.14	3.275	unable to answer

The report of the sub-committee on Oil-Electric Locomotives is signed by R. M. Brown (Chairman), J. H. Emerson and H. A. Hoke.

The report is signed by H. T. Bentley (chairman), Chicago & North Western; H. A. Hoke, Pennsylvania; A. Kearney, Norfolk & Western; Geo. McCormick, Southern Pacific; W. L. Bean, New York, New Haven & Hartford; C. B. Young, Chicago, Burlington & Quincy; M. F. Cox, Louisville & Nashville; W. I. Cantley, Lehigh Valley; C. E. Brooks, Canadian National Railways; G. H. Emerson, Baltimore & Ohio; H. H. Lanning, Atchison, Topeka & Santa Fe; A. H. Fetters, Union Pacific; S. Zwight, Northern Pacific; R. M. Brown, New York Central; H. M. Warden, Missouri-Kansas-Texas.

Discussion

W. A. Powell (Wabash): The figures of 23,000 lb. mentioned in the section on standardization of fundamental parts is used for stress. I understand this refers to the ordinary carbon steel. Does the committee want to suggest a maximum strength for alloy steel such as carbon vanadium steel?

Mr. Lanning: The committee is not prepared to recommend any limits in fiber stresses for alloy steel. Steels of that kind vary too much in their characteristics. It would be better, for the present at least, for the railroads to establish their own limits to govern alloy steel.

Mr. Rink: I don't quite understand why in connection with the fit of driving axles the committee allows ½ in. increased size over the journal, whereas for the engine truck they allow but a ¼ in. I believe ¼ in. is sufficient for the reason that you want to conserve all your material in the wheel hub that you possibly can. I also take exception to their recommendation in connection with standardizing engine truck axles. The journals should be standardized 12 in. in length for the 5-, 6-, 6½- and 7-in. axles. It permits you to standardize the width of your truck frame. It provides more clearance between the equalizers and the frame under the cylinders and works.

In connection with the trailer axle the committee should add another size, 9 in. by 16 in. We are using that size for the reason that we found it necessary on account of our 9 ft. fireboxes and the excessive trailer loads to go to 9 in. by 16 in. axles in order to get the proper bearing pressure per square inch.

Mr. Lanning: I agree entirely with regard to the matter of removing metal from the driving wheel hub, but there is another consideration. Practically every driving axle that fails, fails in the wheel fit, a short distance from the fillet. It has been the experience of more than one railroad that a driving axle which is enlarged only ¼ in. above the journal is subject to failures more than one that is enlarged ½ in. The sizes arrived at here represent the consensus of opinion of different railroads rather than one arrived at by one railroad.

With regard to the 9 in. by 16 in. trailer axle, that size was considered by the committee and by other roads, but the committee feels it is desirable to keep the center of the journal axle bearing as close to the wheel as possible. If a 9 in. by 14 in. journal had been applied to the heavily-loaded trailer axle, good results would have been obtained in so far as hot bearings are concerned and would have had a much lower fiber stress in the axle at the end of the wheel fit.

Mr. Rink: The original engines were equipped with journals 9 in. by 14 in. in size but we found it to our advantage to go to the 9 in. by 16 in. size.

Mr. Purcell: Has any crank axle trouble been experienced on the three-cylinder locomotives? What has developed in the tests that have been made on track stresses? Very light stresses are claimed. We would like to know something about it.

W. L. Cantley (L. V.): We have had no trouble with the crank axle. As to the back end or main rods, we have had no trouble any more than you have trouble with any other bank end or main rod. We have two types of bushings for the back end and main rods. We have four engines equipped with floating bushings and two with the old conventional type of split brass.

Mr. Lipetz: At present there are practically no main rod troubles. There were main rod difficulties in the cast that have been overcome. These troubles were only of such a nature as one may expect to have in every new design. We tried several styles of back ends. We changed the bushings and tried floating bushings and two-piece brasses. There are still some troubles with crank axles and they pertain only to those locomotives where the division of power between two axles has not been resorted to. On locomotives where the three cylinders are divided between two main axles, one cylinder being coupled to the second and the two outside cylinders to the third driving axle, I do not know of any serious crank axle trouble. There are some troubles on those locomotives where all three cylinders are coupled to one axle. These troubles are most probably due to lubrication. This question of lubrication is now being studied and difficulties are being overcome.

In Germany, there are 2,000 three-cylinder locomotives. The design of the crank axle is different. It is made of one solid piece. Besides in Europe, they have oil lubrication and this country prefers grease lubrication. Grease lubrication for the middle pin may not be exactly the thing which should have been used, but as grease lubrication is universal on American roads we have to use it even for the middle pin. The troubles on the crank axle of which you might have heard of are due to heat stresses resulting from insufficient lubrication.

Mr. Purcell: Your experience has been that the solid crank axle has given better results than the built-up axle?

Mr. Lipetz: No, I would not say that. I know that European locomotives are built this way and solid axles do not give such trouble, but at the same time they have also oil lubrication. Whether it is due to the oil lubrication or to the type of axle I cannot say positively.

Mr. Fetters: I can corroborate Mr. Lipetz's remarks about the European practice. They do use a solid crank axle. They lubricate with force feed lubrication with liquid oil, but our axles are larger and sometimes we burn one up. We do not want to throw the entire axle away but want to replace the half axle that has been burned at minimum cost. Mr. McCormick stated to me this morning that they have found no trouble. They had one axle that failed, so far as the crank structure was concerned, one in the 39 engines. We have not had any failures of the structural part of the crank axles with 16 three-cylinder locomotives. We have removed one or two crank axles where the journals were burned up, but we have also removed other axles without a crank, and I presume the Santa Fe removes one once in a while, too. The crank axle is a necessary part of the design of a three-cylinder locomotive and if you absorb the advantages from the paper that were given and the other advantages of the three-cylinder locomotive, it must be apparent to anyone that we should be willing to take a little hard luck once in a great while, if necessary in regard to this crank axle. The fact that we can increase the capacity of the locomotive with a given weight on drivers where we are up to our limit permitted by our bridges, structures, etc., is very encouraging.

R. M. Brown (N. Y. C.): The N. Y. C. has two three-cylinder locomotives. In both cases the third cylinder was installed on an existing type of locomotive. Both of these locomotives are out of service with main rod trouble and have been for some time. We have no trouble at all with the driving axles, that is, the bearings. We have not had to replace an axle on account of a hot driving box or anything of that sort. The middle pin on one of them, the last time we broke the main rod strap, was damaged and we had to borrow a machine to turn that. I wish someone would tell us how to make a main rod that we could put on those two locomotives and keep them going.

Mr. Brooks: There is perhaps more conflicting opinion on the three-cylinder locomotive than there is on any other important mechanical development which has come into use in the last few years. When in Germany last winter, I investigated as carefully as I could the crank axle situation on the German state railways. Without any question, almost all of those axles are made by Krupps, which are the most experienced manufac-

turers of crank axles in the world. The German authorities would not accept a built-up crank axle as a gift after experience with 3,000 locomotives.

Mr. Lipetz: The built-up axle is not an inferior axle. The 250 locomotives in England, of which you heard that they give no trouble, have built-up axles. The Germans prefer the solid axle, but that does not mean that the solid axle is better.

The English railways were using built-up axles even in two inside cylinder locomotives. The built-up axle, if it is well proportioned and of good material, is just as good as any other axle. The question of material is now being studied.

T. D. Doyle (Victorian State Railways): In Victoria, Australia, we have had for many years a number of inside cylinder engines which were designed years ago by British firms. The original engines had solid forged crank axles. We have had them of different materials. Three per cent nickel steel is being used. But we have had an unfortunate experience with regard to the solid crank axle, and some years ago, when the British railways were introducing the built-up crank axle, we decided to do the same.

The built-up crank axle was first applied to one class of locomotives, and it gave such good results that we decided to replace, as required, all crank axles with the built-up type. They have given every satisfaction. We are at the present time building a three-cylinder engine in which the crank is to be of the built-up type.

L. Richardson (B. & M.): Mr. Winterrowd told us that the two-cylinder limited cut-off factor of adhesion is 3.58. You can get the same tractive force in the three cylinders without limited cut-off, and fuel economy is made.

Mr. Lipetz: The French railroads have had four-cylinder locomotives for 40 years, and so did the German and the Spanish railroads. Apparently they have had no trouble with four-cylinder crank axles.

Mr. Brooks: The Germans have had intense trouble with their four-cylinder crank axles, and they pretty near abandoned the whole principle on account of broken axles.

Mr. Lipetz: I do not know that the German railroads have any trouble with crank axles, but I do know that they have been building four-cylinder engines for many years. The Baden and Bavarian railroads are still in favor of four-cylinder locomotives and if it were not for the Prussian Ministry which insists on two- and three-cylinder locomotives, they would have had only four-cylinder locomotives.

Mr. Pownall: We have had five heavy Mikado three-cylinder locomotives in service for three years and they have been through the shop once at about 50,000 or 60,000 miles. They are still running and giving good mileage. They have the built-up axles. We have had a few failures on the main crank pins, but I can't see that you can attribute them to the built-up crank axle. Mr. Lipetz is right in that we must look for improved lubrication and for stronger material.

Mr. Brooks: What failure was there of the crank pin?

Mr. Pownall: It broke in the center.

Mr. Brooks: It did not loosen up in the cheek?

Mr. Pownall: No, sir.

Mr. Fetters: Was it overheated?

Mr. Rownall. It might have been overheated, I could not say.

The Chairman: The report of the subcommittee on the subject of Provision for Expansion of Locomotive Boilers on the Frame, and also Firebox Supports is open for discussion.

Mr. Hawkins: I am not altogether in accord with the recommendations just read as to fastening the waist sheets rigidly to the boiler. My experience has been in a good many cases where this is done we have trouble with cracked shells, although the committee has pointed out the necessity for additional bearing sheets which probably would have avoided some of the troubles which I have experienced personally.

In regard to the firebox support, my experience has been that expansion sheets at the back, where you can use sheets of considerable length work very satisfactorily, but my preference is to have a bearer of ample capacity at the other end of the firebox.

Mr. Pownall: Our experience with the bearer at the front of the firebox has been the same as Mr. Hawkins'. We found it necessary to discontinue the plate design and substitute the sliding bearer, and while we may not have it the proper design, we can hardly concur with recommendation No. 4 as regards the support at the front firebox for that reason.

Mr. Rink: Our experience with frame bracing has been more or less disastrous in that we find it very hard to keep the sheets tight on the angles and T-irons, and we have recently turned out from our shops about 20 locomotives using rivets instead of bolts. I think we are going to meet with some degree of success for the reason that the bolts when they are threaded only penetrate halfway into the sheet, and you do not get the necessary bearing area. I would like to know whether anyone has tried out that scheme in a full installation on a boiler, and with what success?

I believe where it is possible you should use long sheets. I do not like the idea of the use of angle irons on boilers. I think you should confine yourself to T-irons properly machined as outlined by the committee, or use the cast steel "T" with a straight machined surface if there is sufficient length of sheet to permit it.

In the diagram showing the application of a guide yoke brace to a bracket, and side sheet running up to the boiler shell: My experience is that it does not work out in heavy locomotives, and I have recently changed some designs by permitting the inside flange of the bracket to lip underneath the frame so as to take the shear off of the vertical frame bolts. I found that I could raise the guides with a crow bar, due to the fact that those bolts got loose, and the bolts fastening the plate to the T-iron on the boiler shell were also loose.

In fact, I went still further. I put another brace across the lower shell, and tied the 11¾-in. heavy cross bar to the lower brace by means of another sheet, because I wanted to keep that guide yoke down where it belonged.

Mr. Brooks: We had suggested to us today that we could lighten the locomotive by the use of cast steel cylinders to the extent of about 4,000 lb. and I would just like to drop this remark: That for one-fourth of the extra expenditure for cast steel cylinders you can reduce the locomotive the same amount of weight by high-tensile boiler plate.

Mr. Rink: In the table showing replies from four railroads column "A" represents some information which we furnished the committee. I just want to call attention to the estimated life of the power plant, transmission and the depreciation. You will notice the estimated life is rather high and depreciation low. In fact, it is hard after having an engine in service only about a year and a half to estimate just what its life will be, but this engine was in steady service from October, 1925, right up to last month, and the minute we took it off the ground and put the steam locomotive up there again we noticed the difference.

The engine was sent back to the works in order to

have certain improvements added, which were added to subsequent locomotives, and the cost of repairs which we furnished the committee, does not include what you might call a general shopping except that last year we followed the same practice that we usually do with the steam locomotive.

The steam locomotive for the year 1924 made 21,320 mi. That is based on a 6 m.p.h. load, and the average cost per mi., including repairs, fuel and other supplies was .374. For the oil-electric locomotive, after completing one year's service, the miles made were 28,842, and the total cost of repairs, fuel, and other supplies was .172 cents per mile.

The report was accepted and the committee continued.

Passenger Car Construction

By G. E. Smart
Chief of Car Equipment, Canadian National

G. E. Smart

Owing to demands for better, more luxurious and convenient modes of transportation, the designing of passenger cars has become a serious problem, particularly for sleeping cars and cars of the higher class. It would seem that the limit has been reached insofar as size and dead weight are concerned and that further developments would have to be along the lines of decreased weight, more economical use of available space and use of devices to minimize tractive effort required for moving such equipment.

When one considers the proportion of dead weight per passenger, it would be out of the question to decrease the present size of passenger cars, particularly if it in any way reduced the passenger accommodation. Then, owing to the present difficulty of negotiating curves, it would seem that the maximum length has been reached, so it would therefore be reasonable to suppose that the present length, width and height would have to be maintained for some time to come.

Dead Weight

As to weight, this is a detail which cannot receive too much consideration. For instance, taking the present standard sleeping car and the average load, for every passenger the railroads are hauling approximately seven to eight tons of dead weight which, on the face of it, is most uneconomical. However, this has been brought about by the demands of the traveling public and also a desire of railroad officials to provide as safe means of transportation as possible. In any attempt to decrease the weight of present equipment it must not be to the detriment of strength and safety, as, while cars are not designed for operation off the rails, the fact remains that we must guard against the possibility of injury due to collisions and derailments and safety is, and should remain, the first consideration.

The seriousness of dead weight cannot be over-emphasized and there should be great possibilities for designers by the introduction of steel with considerable greater ultimate strength, or some other material which would be equal to the strength of the open hearth steel now used but considerably lighter and which could be produced at a price to warrant its use. In addition to reducing dead weight without seriously affecting the strength, another important factor which must not be overlooked is the final cost, as this has a direct bearing on the revenue producing value of the car. There surely is a great field for investigation and development of some such material.

Corrosion of Steel Coaches

Almost of equal importance to the strength and weight of this material would be its rust-resisting qualities as all roads, I think, are finding now, and particularly in the earlier constructed steel passenger cars, that they are showing deterioration, especially in the side sheets, roof and flooring, to such an extent as to make this a serious matter and one which should be carefully considered in selection of materials.

There are also great possibilities of dead weight reduction by the use of articulated cars. In Europe they have, in some instances, articulated the whole train, thereby making a considerable saving in weight and also in cost of construction, but it is a question whether the articulated principle can be adopted to the same extent in this country, particularly in main line service, as the cars must be used in trains kept as one unit during their entire trip. On trains which have to be disturbed the use of the articulated principle would be impractical. There should, however, be possibilities for this equipment in suburban trains or other places where the service required is uniform, for trains between two large centers, and where the cars could be kept in a particular service.

Roller Bearings

The roller bearing is a live question and a number of roads are testing out different types. From the results so far it would seem that further exhaustive tests should be made with the idea of finally perfecting the design to such an extent as to warrant its universal use, as the saving in tractive effort required in handling a train equipped with roller bearings is so considerable that it may eventually reduce the power unit.

The use of roller bearings means in many cases a change in the pedestal, increasing the width between the jaws so as to provide room for a bearing of proper design and strength. On new cars this can easily be arranged without additional expense, but on existing equipment it means, in most cases, changing pedestals and redesigning equalizers. Eventually I believe that only one or possibly two designs will be standard so that equipment can be interchanged without having to keep various types of axles and boxes for use when wheels are changed.

To analyze completely present design and construction in all details would require a paper of a length impractical for this meeting and I have, therefore, only touched on a few items which seem to be most important. I feel that the greater possibilities for immediate improvement in passenger car construction are the use of suitable roller bearings, and the use of lighter material to replace the grade of steel which we are now using. However, I would like to mention, briefly, a few other details which warrant thought.

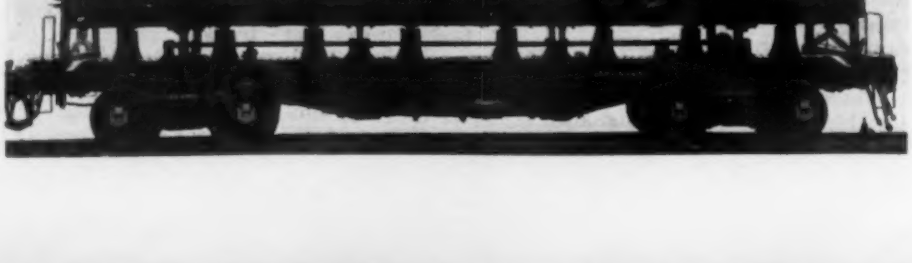
We now lock the body of the car to the center truck bolster, but this member is attached to the cross bolsters by only a few bolts. Would it not be advisable to combine these castings into one and thereby carry out the principle of locking the body securely to the truck as a matter of positive safety?

A Suggestion for Lighter Sleeping Cars

In view of the small average number of passengers carried in sleeping cars, would it not be advisable to eliminate the upper berths, thereby saving considerable weight equipment such as bedding, and cost of construction? This would make it possible

Dump Car Built by the National Steel Car Corporation, Ltd.

Capacity, 50 tons
Light weight, 68,000 lb.
Inside length, 34 ft.
Inside width, 8 ft. 11¼ in.
Cubic capacity, 30 cu. yds.
Air operated
Built, August, 1926



to use turtle-back roofs, thereby still further reducing weight and cost.

The use of steel for roofs is objectionable from a maintenance standpoint, due to rapid deterioration, but makes a lighter construction than wood and canvas. The steel roof eliminates creaking due to its rigidity and reduces weight by dispensing with the great amount of furring necessary for the attachment of the roof.

Equipment Expenditures and Transportation Efficiency

By William J. Cunningham
Professor of Transportation, Harvard University, Cambridge, Mass.

W. J. Cunningham

Since the beginning of the present century the expenses of maintaining equipment have increased relatively much more than other expenses, but the additional expenses in maintaining equipment have purchased economies of much greater magnitude in transportation. The remarkable increases in operating efficiency during recent years, particularly in the period since the war, are creditable in large part to advances in the design and maintenance of locomotives and cars, and the importance and prestige of the mechanical department in railroad organization as a whole have been correspondingly enhanced.

Increase in Equipment Maintenance Cost

The fact that the expenses of maintaining locomotives and cars have been increasing steadily and in greater degree than the increases in other departmental expenses is fairly well known, but is not generally comprehended either as to extent or in significance. Prior to 1904 the total expenses for maintaining equipment were less than those chargeable to maintenance of way and structures. In 1904 the two groups of expenses were practically the same. Since then the tendency has been for maintenance of way and transportation expenses to decline relatively and for maintenance of equipment expenses to grow relatively.

Because of changes in the accounting classifications of the Interstate Commerce Commission it is not possible to make a scrupulously exact comparison of the 1926 expenses by general accounts with those of any year prior to 1915, but with slight qualifications the comparison may be extended backward to 1908. Prior to 1908 the transportation expenses included nearly all of the expenses now classified in the group called "traffic expenses," as well as the net debit or credit balances for joint use of freight cars, hire of other equipment, and rent of facilities, now transferred from expenses to additions to or deductions from income. Yet by making adjustments which in greater part compensate for these differences in accounting methods it is possible to afford an approximate comparison of the results in 1926 with those in 1901, a period of 25 years. Such adjustments have here been made in the 1901 figures, as the transportation expenses have been restated. The 1901 figures are for all railroads in the United States. Those for 1926 are for Class 1 railroads only, but inasmuch as the significance of the comparison lies in the relative percentages of increase and in the changes in relative proportions of total, this discrepancy in the basic figures has little bearing upon the comparative indices.

These figures indicate strikingly the reversal of relationship in the two maintenance accounts and the substantial reduction in the relative magnitude of transportation expenses. In 1901 the maintenance of way ratio to the total was 23.4 per cent while the maintenance of equipment was but 19.2 per cent. In 1926 the way and structures ratio fell to 18.5 per cent, while the equipment ratio advanced to 27.4 per cent. Transportation declined from 51.0 per cent to 46.9 per cent. Or, in other comparative terms, the 25-year increase in way and structures total was 278 per cent; in transportation it was 337 per cent; while in equipment it was 579 per cent. The increase in equipment expenses was over twice as great relatively as the increase in way and structures, and was nearly one and three-quarters as great relatively as the increase in transportation expenses.

Total Operating Expenses for 1926 Compared with 1901

	1926	1901	Per cent increase 1926 over 1901	Per cent of total 1926	Per cent of total 1901
M. of W. and S.	$874,244,048	$231,056,602	278	18.5	23.4
M. of E.	$1,291,919,172	$190,299,560	579	27.4	19.2
Transportation	$2,209,245,908	$505,163,886	337	46.9	51.0
Other	$339,612,750	$63,653,915	433	7.2	6.4
Total	$4,715,021,878	$990,173,963	376	100.0	100.0

Turning from the 25-year comparison, in which the earlier figures are subject to some qualification because of changes in accounting methods, we may place the 1926 figures alongside of those for 1908, the first year under the accounting classification effective July 1, 1907. Since then there have been but few changes in the general accounts and, with but one adjustment for maintenance of work equipment, the 1908 figures may safely be compared with those of 1926.

While the degree of change in the relationships between departmental expenses was not as striking as in the 1926-1901 comparison, nevertheless, the differences are notable. Between 1901 and 1908 the equipment expenses grew so fast that in 1904 they exceeded the way and structures expenses where as in 1901, equipment was the lower of the two. During the 18-year period from 1908 to 1926 way and structures expenses showed little change in their relation to the total—19.3 per cent in 1908 and 18.5 per cent in 1926—but the equipment expenses jumped from 22.5 per cent of the total in 1908 to 27.4 per cent of the total in 1926, and transportation expenses were reduced from 52.1 per cent of the total in 1908 to 46.9 per cent of the total in 1926. In other terms, the increase in transportation expenses during the 18-year period was 159 per cent, the increase in way and

Total Operating Expenses for 1926 Compared with 1908

	1926	1908	Per cent increase 1926 over 1908	Per cent of total 1926	Per cent of total 1908
M. of W. and S.	$874,244,048	$314,100,349	178	18.5	19.3
M. of E.	$1,291,919,172	$366,168,273	253	27.4	22.5
Transportation	$2,209,245,908	$851,443,784	159	46.9	52.1
Other	$339,612,750	$99,797,548	240	7.2	6.1
Total	$4,715,021,878	$1,631,509,954	189	100.0	100.0

structures maintenance was 178 per cent, and the increase in equipment maintenance was 253 per cent. The absolute increase in equipment maintenance was 1.4 times as great as the absolute increase in way and structures maintenance, and 1.6 times as great as the absolute increase in transportation expenses.

The Significance of the Changed Relationships

The proportionately greater cost of maintaining locomotives and cars than of maintaining way and structures and of conducting transportation, is not an indictment of the efficiency of the mechanical department. Instead, in the main, it is the reflex of important advances in the art of transportation. The notable achievement in the constant increases in the train load and otherwise in producing more units of transportation—ton-miles and passenger miles—with less units of work—locomotive miles, train miles, car miles, train crew hours, and tons of fuel consumed—have been made possible in large part by the steady development in the power, capacity and efficiency of equipment. Heavier and more powerful locomotives, with economizing devices such as superheaters, feedwater heaters, mechanical stokers, boosters and the like, and the use of larger capacity cars, produce more ton-miles per train miles, per train crew hour and per ton of fuel, but they add to equipment maintenance costs. The striking increase in freight transportation efficiency, then, has been purchased in substantial part by heavier costs in maintenance of locomotives and cars but the net result has been a lower total ton-mile cost and the ability to increase the capacity of lines and terminals.

Effect of Modern Facilities and Equipment on Maintenance Expenses

It may be suggested that the heavier trains and the use of heavier locomotives and cars have necessitated heavier rails, more ties, more ballast and in general higher standards in the entire roadbed, track superstructure and structures, as well as in the maintenance cost of shops, enginehouses, fuel stations and other structures and facilities devoted to equipment use but chargeable to the maintenance of way and structures, and that therefore the cost of maintaining way and structures would be burdened correspondingly. Yet while it is true that modern equipment and modern methods of train operation demand higher standards in way and structures it does not follow that the total of way and structures maintenance expense should increase relatively as much as equipment maintenance.

Improvements in way and structures do not entail additional maintenance costs in the same degree as the developments in locomotives and cars increase equipment maintenance costs. In fact, many of the developments in way and structures actually reduce rather than increase the maintenance burden. The return from a large part of the advances in maintenance of way engineering are in the form of reduced maintenance of way expenses as, for example, in treated ties. Another substantial part, as with deeper or better ballast, heavier rails, and steel or concrete structures instead of wood, bear heavily upon capital expenditures and yield their return in the lower cost of upkeep. Similarly, the capital account assumes the greater part of the cost of reducing grades and curvature but the benefit accrues both to maintenance of way expenses and transportation cost.

The essential difference between the development in way and structures on the one hand and locomotives and cars on the other hand, is that the better way and structures yield economies in maintenance as well as in transportation, while the heavier locomotives, with their complicated economizing devices, and the larger capacity cars, add substantially to equipment maintenance costs and almost the entire benefit accrues in the form of lower transportation costs.

Recent Improvements in Operating Efficiency

It would be neither fair nor proper to press the point unduly that the advances in equipment standards have been responsible for the recent remarkable achievements in transportation efficiency. To those in executive positions who have had the vision and the courage to take the responsibility for the very large additional capital expenditures since the war, due credit must be given. The enlargements and improvements in terminals, running tracks, automatic signaling, heavier bridges and improved structures and other facilities, have contributed their part. The improved service of the supply department has had its influence on the efficiency of maintenance. And finally, the steady increase in the skill, resourcefulness and energy of the transportation department should be adequately recognized. Yet with due credit to all other branches of the service, the mechanical department deserves high tribute for the substantial and steady advance in designing equipment to meet effectively and efficiently the heavier demands of transportation and for maintaining locomotives and cars so that the transportation department could give adequate and dependable service.

Except in the important factor of return on property investment, the railroad record of 1926 is one of superlatives. It had the largest volume of ton-miles, the greatest operating revenues, the largest net income, the highest operating efficiency, and the standard of public service was never before equalled in quality. The record as a whole is encouraging to those, charged with the determination of executive policies, who during the past six years have courageously invested about $800,000,000 per year in capital improvements on the railroads of the United States, even though the return on the total investment in a year with such favorable results otherwise is disappointingly low. That courage is born of a faith that the Transportation Act of 1920 means what it says in Section 15-a, namely, that the railroads as a whole, or collectively in territorial groups, shall be permitted to earn a fair return on the value of property devoted to public service, if operated with honesty, efficiency and economy. The return last year was better than in any year since the act was passed but it was too far short of a fair return.

It is not my intention to enter upon a discussion of this highly important phase of economics. I refer to it merely to give me the opportunity to develop the point that in so far as operating efficiency is concerned the railroads are before the public with clean hands.

Four Years of Progress in Operating Efficiency

It is not necessary to go back many years to demonstrate the striking gains in transportation efficiency. The comparison may be limited to 1926 and 1922. In taking 1922 as the base I am passing up the opportunity of showing the greater gains that would be apparent if 1921, the first complete year under the 1920 law, were taken as the base. But 1921 was a year of subnormal traffic and may not fairly be used. To a certain extent the 1922 base was adversely affected by the strike of shop employees, but the results of that strike bore more heavily upon 1923. The program of additions and betterments, which as already mentioned has resulted in yearly additional investments of about $800,000,000, was well under way in 1922.

Here are a few of the significant indices of operating

efficiency in the two years—1922 and 1926. The traffic density in net ton-miles per mile of road per day in 1922 was 4,405; in 1926 it was 5,688, an increase of 29 per cent. With the larger volume of traffic it would be natural to look for more economical performance but in this case the increase was so substantial as to invite congestion through the overtaxing of facilities. Instead of congestion, however, the year 1926 was practically free from any interruption to expeditious movement or from any shortage of equipment. The service was never so free from congestion, delay and car shortage, although the volume of traffic exceeded all previous records.

In train operation the following are the significant units. The gross train load in 1922 was 1,466 tons; in 1926 it was 1,737 tons, a gain of 271 tons or 18 per cent. The net train load in 1922 was 677 tons; in 1926 it was 772 tons, an increase of 95 tons or 14 per cent. The smaller gain in net than in gross appears to be due to the greater percentage of empty car movement in 1926.

The train speed in 1922 was 11.1 miles per hour; in 1926 it was 11.9 miles per hour, an increase of seven per cent.

If the gross ton-miles of 1926 had been produced by trains of the same weight as those of 1922, the 1926 train miles would have been 749,447,000 instead of 632,557,000, an excess of 18 per cent. The heavier train load of 1926 saved 116,890,000 freight train miles.

This estimate of saving, however, takes account only of the better train load. It neglects the gain in train speed. Both load and speed are combined in the unit "gross ton-miles per train hour." In 1922 the gross ton-miles per freight train hour were 16,213; in 1926, they were 20,705, an increase of 28 per cent. If the 1926 freight traffic had been moved with the 1922 efficiency in train load and train speed, the train hours would have been 67,766,113 instead of 53,064,819. The higher degree of efficiency in 1926, therefore, saved 14,701,294 freight train hours or 28 per cent in those expenses which vary directly with train hours.

In 1922 the fuel consumption was 163 lb. per 1,000 gross ton miles; in 1926 the comparable unit was 137 lb., a saving of 26 lb. or 16 per cent in fuel cost. If the 1926 fuel efficiency had been the same as in 1922 the fuel consumption in freight train service in 1926 would have been 101,563,181 tons instead of 85,058,218, an increase of 16,504,963 tons or 19 per cent in the fuel bill for freight service alone. Likewise, in passenger service if the 1922 unit of 17.9 lb. per car mile had been in effect in 1926 (instead of 15.8 lb.) the fuel consumption in passenger service would have been 33,937,308 tons instead of 29,999,277 tons, an increase of 3,938,031 tons or 13.1 per cent in the fuel bill for passenger service. Combining both freight and passenger services, but not including yard service (for which the data are not available on a unit basis) the decrease in the cost of fuel in train service in 1926, because of superior equipment and better operating methods in comparison with 1922, was about 20½ million tons.

The gains in freight car efficiency are similarly impressive. The car miles per car day in 1922 were 23.5; in 1926 they were 30.4, a gain of 29 per cent. The average car load in 1922 was 26.9 tons; in 1926 it was 27.4 tons, an increase of 2 per cent. Where there was a slight decrease in the percentage loaded of total car miles, the resultant of the three factors—net ton miles per car day—was a marked improvement, 424 in 1922 and 532 in 1926. The gain in the ton mile productivity of cars, therefore, was over 25 per cent. If the 1926 traffic had been handled with the 1922 freight car efficiency, the cars required to produce the 1926 ton miles would have been 3,155,000 or 637,000 cars more than were actually available. The better utilization of cars in 1926 was made possible mainly by the quicker turnover at terminals, the smaller delay at inspection and interchange points and in repair yards and shops, the speedier movement on the line, and the reduction in the number of unserviceable cars from 12.8 per cent in 1922 to 6.5 per cent in 1926.

These are the high spots in the 1926 record. Many other evidences of substantial improvement in efficiency might be cited as well as the intangible but highly important factor of quicker dispatch and dependability of service from the viewpoint of the public. The higher quality of service since 1922 has brought about what is almost a fundamental change in purchasing policies so that manufacturers and merchants are getting along with much smaller inventories and in many cases are saving a substantial part of the freight bills by the reduction in the interest charges on their smaller stocks.

As has already been stated the recent achievements of railroads are the results of capital improvements, better equipment and facilities, better operating methods, and better team work on the part of all departments of the service. To these commendable results the mechanical department has made substantial contributions and its officers of all grades have abundant reason to feel proud of their part in the satisfactory performance.

A Look Into the Future

By Arthur J. Wood

Professor of Mechanical Engineering, The Pennsylvania State College, State College, Pa.

Arthur J. Wood

The major problem of today is to haul, at allowable high speeds, one ton, one mile at the lowest possible cost. With increasing operating costs, the time factor became of the greatest importance. The problem of tomorrow will be a more complex one, involving in addition to the major problem of today, motor competition on the highways, more exacting requirements for comfort and convenience due to our higher average standards of living, and more clearly defined supervisory and technical functions.

The most serious problem that recently faced the railroads in this country has been the increasing cost of operation, but even this is being stabilized. The cost consists largely of labor, fuel, materials, and maintenance and these are closely related one with the other. Since the first three predominate, the problem reduces to increasing the output of the individual, to using a larger percentage of the available energy of fuel and to obtaining materials which will stand the gaff, thus lowering the maintenance.

Materials and maintenance costs may be so adjusted that an increase in the cost of the first may mean a decrease in the cost of the second, as for example the selection and application of the best kind of metal to be used in axles, boiler plates, side rods and stay bolts.

Another illustration relates to the lubrication of journal boxes. In 1894, a Committee of the Master Car Builders' Association reported an estimate of one hot box detention for every 20,000 car miles operated and that the cost was 24 cents per 1,000 miles. In 1916, a certain railroad frequently had one hot box detention for each 30,000 miles. During March and April, 1927, this road showed over 700,000 car miles per hot box detention in passenger service. The chief chemist states: "The reduction of cost since 1894 is largely due to the fact that at that time compounded oils were generally used, and at the present time we are

using petroleum oils which are not compounded. Much of our reduction in the number of detentions has been due to carefully selecting oils to exclude those which contained objectionable tarry matter, and we have also materially reduced the viscosity of oils used, thereby diminishing the internal friction and running temperatures of the bearings." The extra cost in this case was not in the material itself, but in the investigations which led to the proper use of the most desirable lubricant.

The economic adjustment between materials and maintenance offers one of the greatest possibilities for the technical staff.

The Problem Stated

A new factor has recently entered into the technical functions of the engineer. Twenty-five years ago, the supply industry held a relatively unimportant place in the development of the mechanical requirements of the railroads. The problems confronting the locomotive and car departments were relatively simple. Today, the supply industry has grown to enormous proportions and in addition to developing its engineering personnel from outside sources, approximately 43 per cent* of the executive technical officers and the supply staffs of railway supply concerns, appointed or promoted since 1919, have been recruited from the mechanical departments of the Class I railroads.

With rapid developments, there has come a tremendous increase in the complexity of both the locomotive and car problems and the questions now confronting the railroad mechanical officers in making decisions on new equipment are often related to branches of engineering, somewhat remote from the direct problem of motive power. I refer to such subjects as heating and ventilation, heat transmission, lubrication, chemistry of combustion, corrosion and lighting.

This general situation also has a direct bearing on the question of the railroads and the colleges. It is my observation that four graduates in mechanical engineering go with railroad supply companies to one who enters the service of the railroads.

As in the past, there is a "romance of the rail" but this does not mean quite the same as it did earlier in this century. Other industries also hold out enticements for the oncoming generation. Contrary to a general belief, the curve of average earnings of mechanical engineers employed by railroads is above that for industries at large;† but, with few exceptions, the railroads have not entered the same as has other industries into the competition for obtaining the best product of the engineering schools. It is my prediction that if you aim to secure and hold the desirable technical graduates you must recast your methods of recruiting, training and placement of these men. The proper selection of promising recruits is as important as the selection of materials, and is a more difficult task. This whole question must enter into the future of the railroads, but let me assure you that we of the colleges share with you the responsibilities in this matter. The utilization of the college trained man is a subject to which the Mechanical Division may well afford to give more attention.

Technical Societies

During the period of the growth of the railroad supply industry, technical societies have taken a significant place in furthering engineering progress. The fields of electric power, refrigeration, heating and ventilation, gas power, chemical engineering, hydraulics, materials of construction, machine tools, management, foundry practice, and many other are well organized through their respective societies. In the main, their problems are also yours, for railroad engineering comprehends a vast field of endeavor.

Of all the societies, the American Society of Mechanical Engineers probably comes the nearest to your interests and its Railroad Division, above all others, ought to have your co-operation. Its policy is to confine its work to the highly technical problems of railroad mechanical engineering and should be an incentive and assistance to the Mechanical Division of the A. R. A., rather than divert any of its functions or activities.

Other Facilities

Again, there have been developed expensive and excellent laboratory facilities in our engineering schools and most of these are in active service but three-fourths of the time each year. The elaborate and classic tests instigated and supported by the Mechanical Division and now in progress at Purdue University, is a forward step of great significance.

While the first and most important job of a university is to teach, there are many institutions that have developed special facilities along certain lines. One has worked for years in furthering the science of heat transmission, another has specialized in internal combustion engines, a number have outstanding facilities for metallurgical, heat treating and allied fields, while others have become recognized in the field of combustion, heating and ventilating and industrial chemistry. There may soon come a time when these organized agencies may serve the railroads as never before.

The engineering experiment stations, some 20 in number and manned by some of the best technical men in the country, are undertaking practical research problems, as important to the railroad engineer as to industry at large. Usually, problems dealing with fundamental reasearch are carried on by these state supported laboratories, but many industrial companies co-operate in tests on some of the work having a commercial bearing. The University of Illinois has issued 160 bulletins from its station, of which 10 or more are on railroad mechanical subjects. The Engineering Experiment Station at The Pennsylvania State College has expended in 15 years at least $100,000 in the very practical subject of heat transmission. Many of the stations are equipped to carry out work in special fields of engineering.

Car heating is an important subject, but notwithstanding recent improvements the data available are neither satisfactory nor conclusive. The whole field should be reviewed in the light of economy and of comfort to passengers, and in this, as in most of the new developments, the railroad officers and the railroad supply interests must work together in the spirit of "give and take." The questions raised bring out the interrelation of our engineering problems, a point which I aim to emphasize in this paper. They also indicate that more experimental work is needed. The Research Laboratory of the American Society of Heating and Ventilating Engineers is working on many problems directly related to your interests.

Other Problems

Although appearing in a different aspect, questions of the same nature remain unanswered for some of the preventable heat losses in the locomotive and in refrigerator cars. As a further illustration of interest in health and comfort, mention may be made that a research laboratory, not connected with a railroad, was recently asked to advise on methods of cooling passenger cars during the times of excessive heat. The mere suggestion of a Pullman car kept at 72 deg. F. in the summer season, with the windows closed keeping out noise and dirt, brings satisfaction to the traveler. Surely the engineer has a duty to perform in addition to the development and care of material things, wonderful as they are. I expect to see the day when practically all dining cars will have their individual mechanical refrigerators and when refrigerator cars will, for the most part, be cooled by mechanical means, using an improved compressor system, or working on the absorption principle.

Improvements and refinements of this character are directly related to the question of rates charged, but experience is somewhat convincing that the people will pay for safeguards to their health.

Railroad officers fully appreciate the importance of such problems as those cited in this paper and of their application to the broad field of transportation. Would it not be of direct benefit to the greatest industry in this country to provide a central bureau of study and investigation where problems of common concern could be reviewed, analyzed and reported upon?

The demands of the present call for a new angle of approach in the solution of many problems. The Master Mechanics and Master Car Builders Associations have rendered an invaluable service, and the Mechanical Division will continue to establish standards and recommended practice. The Bureau of Railway Economics is also filling a real need, but I fail to find a clearing house for the review of the more purely technical railroad mechanical and electrical problems.

Looking to the future, and as a step toward economy of time, effort and money, would it not be desirable to establish and maintain a bureau of co-ordination for technical problems? To such a bureau might also be assigned the task of formulating necessary or desirable recommendations as they affect all railroads in the selection, training and placement of engineering graduates.

The Future of Motive Power

Turn, if you will, to a topic which is uppermost in our minds—the future of motive power. Many agree that the greatest single possibility lies along the lines of new developments in the utilization of fuel. A lower average rate of coal burned per square foot of grate giving increased capacity and made possible in part by the four-wheel trailing truck, the correct proportioning of grate area and firebox volume, the extended application of water tube boilers, pre-heating air for combustion, application of induced draft, thus reducing the back pressure in the cylinders, the use of higher steam temperatures, which will introduce new problems in superheat, reduction of losses in heat exchange to the cylinder walls, and new developments in design of feed-water heaters for locomotives, are some of the problems before us. As in stationary practice, the boiler development has usually lagged behind the engine development. In these questions, capacity vs. economy call for a more extended study.

*From report presented by the Sub-Committee on Professional Service of the Railroad Division, at the annual meeting of the American Society of Mechanical Engineers, December 7, 1926.

†See *Railway Age*, December 11, 1926, page 1153.

Both mechanical and air atomization of liquid fuel are being developed to give a better and a more positive control of combustion. If, by this means, it becomes possible to liberate more heat without exceeding the present temperatures, the percentage of jacket loss may be materially reduced. This should lead to a more powerful engine for the same weight, without a decrease in the thermal efficiency of the actual engine. Moreover, it seems increasingly probable that solid fuel, such as pulverized coal may be successfully adapted to the Diesel engine with consequent material reduction in fuel costs.

With the present metallurgical developments, the upper limit for the steam engine seems to be one of temperature, approximately 750 deg. F. This may be reached by high pressure and moderate superheat, or by lower pressure and higher superheat. Reheating and regenerative cycles offer thermodynamic possibilities which have not been fully investigated. But taking advantage of all these refinements, the present margin for improvements is relatively small, probably in the neighborhood of 10 per cent over the present efficiency, which means an increase to only 10 per cent over-all efficiency, if we can now attain even as high as 9 per cent. There are limits in refinements beyond which we should not attempt to go; other possibilities, as savings by roller bearings, better steam heating, etc., should be given more attention.

Modernization must not be carried to the extreme and to the detriment of other improvements. It takes men of experience, sound training and clear vision to decide wisely many of these questions. The bigger the organization the more is the call for executive ability at the top; executive ability and a research mind are not commonly found in the same individual. All this takes us back to my reference to the complexity of the problems before the mechanical staff of the railroads.

Influence on Design by Locomotive Test Plants

The great advance in our industrial progress in the last 25 years can be traced directly to the increasing interest in science and research, which involves accurate methods of testing. A striking illustration, as applied to locomotive development, is found in the influence exerted by locomotive test plants, and without which it is safe to state that findings as noted below could not have been obtained with any degree of assurance.

Among other results, the Purdue test plant gave a new meaning to the factors limiting indicated horsepower and rates of combustion and for the first time it brought out the relation between cut-off and steam consumption as influenced by speed. It was also shown that the draft producing action of the exhaust steam was independent of the intermittency of tho exhaust, the essential factor in the suction produced being the quantity of steam exhausted. Lawford H. Fry has pointed out that this is often overlooked, particularly when the claim is made that a multi-cylinder locomotive gives a more efficient exhaust action. With the results now available for three-cylinder locomotives, would it not be desirable to recheck the effect of intermittency of exhaust?

The Pennsylvania Railroad locomotive testing plant, originally located at the St. Louis Exposition, and since 1905 at Altoona, has been constantly accumulating a veritable gold mine of information, which has made possible continued improvements in design. A few of the many results may be noted: The determination of maximum rate of evaporation per hour per square foot of fire area, diameter of piston valves for cylinders up to 30 in. in diameter, the greatly increased rate of unit evaporation of short tubes over long tubes, the quantity of water evaporated for one square foot of free air space through the fuel bed support, effect of varying amounts of superheat on steam consumption, advantage gained in boiler efficiency by the use of fire-brick arch when high volatile coal is burned, losses as determined by a heat balance from tests, heat absorbed by the superheater as compared with that absorbed by the water heating surface, losses in steam pressure between boiler and cylinder, most economical point of cut-off, and economy effected by feed-water heaters.

The list of findings might be greatly extended, but is sufficient to remind us of results definitely accomplished by these pioneer plants. It indicates one of the means by which the steam locomotive has met the challenge of competition during the past 20 years; but more than this, it suggests the necessity of more research and testing all along the line, lest others take from you the business, and with it the willingness of the people to back improvements and continue reconstruction.

Looking beyond the present, let me urge you to get behind the men who are doing development work and turn over to them the facilities which they must have to go on with their labors. It is no longer a question if the railroads can afford to do this. Can they afford *not* to do it?

In view of the present situation, as briefly outlined in this paper, but with no thought of slowing up the work which is being undertaken by individual companies, I see a real need for the establishment of a Bureau of Investigation which would be supported by all railroads. It might properly be combined with the suggestion noted earlier in this address, and the two function as a "Bureau of Co-ordination and Investigation." This general idea was recently submitted to a leading member of the Mechanical Division, who expressed himself in the following words concerning the proposal:

"The establishment of a bureau of research supported by all railroads and properly supervised so that the results of their efforts would be based entirely on improvement would, in my opinion, definitely cheapen transportation, and improve service, as well as be most desirable. Such action would result in coordinating the best thought on any subject and at the same time make it possible to gain expressions from institutions such as yours, which have specialized in certain research activities, so that economy of expenditures could be preserved over what would obtain if a central bureau as established demanding facilities for making appropriate research work in all branches of railroad activities."

For year, the National Research Council has served many industries by substantially just such a plan. As a member of the executive committee of one of its divisions, I am acquainted with the results obtained during the past few years in the field of heat transmission and am confident that the art would not be as far advanced or the service rendered be as extended had not this work been centralized through the co-ordinating agency of the council.

Reviewing with you some of the aspects of a new economic era in railroading, I would close by reminding the Mechanical Division that the big problem the engineer must solve is how to meet the inevitable demands that will be placed against his ability tomorrow. This problem is facing us. What will be *your* answer to it? I have ventured to suggest some of the means at hand which should aid in a satisfactory solution.

The Next Step in the Development of Locomotive Drafting

By W. F. M. Goss
Affiliated Member

Dr. W. F. M. Goss

(In this paper Dr. Goss presents a comprehensive review of the development of draft and draft appliances used in the modern steam locomotive and forecasts probable future development of a turbo-exhauster shown by service tests to have many important advantages. Following a detailed reference to early attempts at drafting locomotives, the Von Borries-Troske tests, the American Engineer stack tests and the Association's stack tests and paying earnest tribute to the early experimenters in draft production such as Robert Quail, G. M. Basford and H. H. Vaughan, Dr. Goss continues his paper as shown in the folowing abstract.—Editor.)

It will already have been surmised that the next step in locomotive drafting involves the use of a suitably designed and suitably driven exhaust-fan. I have approached my subject with deliberation because I appreciate the reluctance with which locomotive men contemplate such a process. They know it to be a historic fact, that exhaust-fans have been tried on locomotives at various times and in many places, and that they have never been continued in service. It has become a tradition with railroad men that exhaust-fans in locomotive service have always failed. The reasons for their failure, whether the conception was at fault or the design poor, or the materials badly chosen, are rarely sought, and tradition holds its sway.

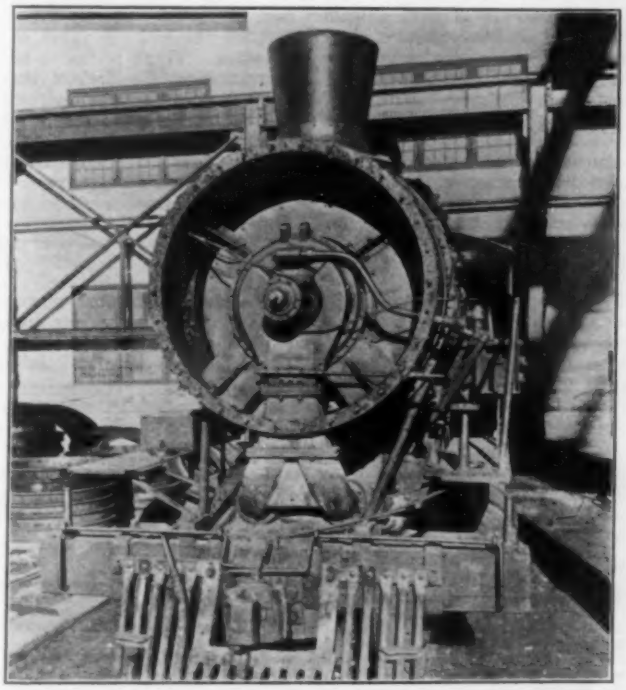
If, now, instead of relying upon the tenets of traditions, we approach this subject from the standpoint of scientific inquiry, we are at once freed from many conservative restraints. The problem is one which I have carefully studied. I have been fortunate in having had the co-operation of able interests in the development of designs, in the conduct of laboratory experiments, and in tests of an experimentally equipped locomotive on the road; all with the result that much reliable information concerning the possibilities of the exhaust-fan in locomotive service

is now available. In fact, speaking from a scientific point of view, mechanical draft in locomotive service is today better understood than was the present front-end with its open exhaust-jet before this Association had undertaken its development, thirty years ago.

Darius Green attempting flight by chance, failed in his purpose, and established a tradition that flight by man was impracticable; the Wright Brothers, guided by scientific procedures, shattered that tradition and attained successful flight. The art of producing draft in locomotive service has now reached a condition of scientific stability. The theory underlying design of exhaust-fans for producing draft, and of steam turbines for driving them is now well understood; our range of choice in the selection of materials from which to construct such equipment has, in recent years, been extended, and men of skill are ready to proceed with the details of design. We never really achieve until we are able to step beyond the limits of present day accomplishments. It is time for the next step. Shall we take it?

The Turbo-Exhauster

A decision to proceed with the installation of mechanical draft in locomotive service at once opens the way for many different arrangements of details. I have preferred to work on an application of an exhaust-fan, directly connected with a steam turbine energized by the exhaust steam from the locomotive cylinders. The combination of turbine and fan, hereinafter referred to as the "turbo-exhauster," is a self-contained unit having a single shaft carrying a steam-turbine wheel at one end, and an exhaust-fan wheel at the other. The locomotive exhausts directly into the steam-supply header of the turbine, from which it passes through nozzles of appropriate size to the turbine wheel. The turbine takes all the exhaust from the locomotive cylinders, not a part of it. The nozzles of the turbine are the exhaust-tips of the new arrangement. The steam having done its work on the turbine-wheel is discharged



Turbo-Exhauster in Place, Showing Steam Connection Between Exhaust Ports and Turbo, and Blower-Pipe Connections for Road Experimentation

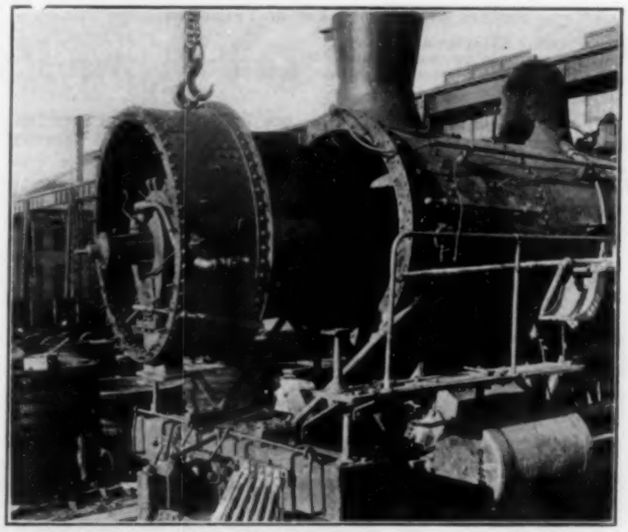
into a casing which conveys it along the shaft of the turbo-exhauster to a point close to the back of the fan-wheel, where it flows in a steady stream into the front-end.

The course of the exhaust from the turbine wheel to the front-end is such that it maintains an atmosphere of exhaust steam about the journals and bearing of the turbo-exhauster and at the back of the exhaust fan wheel. The pressure of this steam is merely the pressure of the front-end, and its temperature can never be higher than the temperature of steam at or below atmospheric pressure. This arrangement entirely disposes of any trouble which might otherwise be anticipated in maintaining journals and journal boxes within the front-end of a locomotive.

The turbo-exhauster has no valves or governors or other elements of control. All steam that the locomotive exhausts goes to the turbine wheel and the energy that it imparts to the turbine wheel is absorbed by the exhaust-fan wheel, so that the draft action induced by the turbo-exhauster responds to the volume of steam exhausted by the locomotive just as does the draft action in the presence of the open exhaust-jet now in use.

The exhaust of air pumps and of other steam auxiliaries is piped into the steam-header of the turbine, where is goes the same course as the exhaust from the locomotive cylinders. Experiments have shown that the exhaust from the air pump alone is quite sufficient to keep the turbo-exhauster in motion when the throttle of the locomotive is closed, so that on the road the turbo-exhauster never stops, though its speed may vary between very wide limits.

Quite independent of the steam-supply casing of the turbine



Turbo-Exhauster in Ring in Process of Application for Experimentation—All Parts of the Device Go with the Ring

is a small high-pressure steam header covering a nest of high-pressure nozzles arranged to act upon the turbine wheel. The usual blower pipe connects with this high-pressure header. In firing up, the roundhouse steam hose is attached to blower pipe, steam is turned on, and the turbo-exhauster, operating as a high-pressure steam turbine in quietness and efficiency not otherwise obtained, begins its work. The blower may be used as needed, not only when the throttle is closed but also on the road, when the throttle is open, and there is need of a real draft booster. The fact that the blower nozzles are independent of the exhaust nozzles permits them to be effective when worked either independently or in combination with the others.

The turbo-exhauster as a whole is arranged in the front-end immediately ahead of the superheater. Its shaft is parallel but not necessarily in line with the center line of boiler. In its application to existing locomotives it will often be found practicable to put it into existing front-ends, but the preferred arrangement is one which provides a short extension front-end ring within which all parts of the turbo-exhauster may be permanently installed. The stack is ordinarily moved forward to the new ring and the old stack-base sealed by a man-hole cover, by the removal of which, admission is given for inspection of superheater, and related parts. When a full exposure of the front-end is necessary, the supplemental ring carring out with it all parts of the turbo-exhauster is easily and quickly removed.

The turbo-exhauster presents no difficulties either of design or application arising from scientific considerations. Its fundamental details have all been analyzed and tested. Assuming that the functions it performs are desirable functions, its scientific soundness should insure its ultimate introduction.

The Turbo-Exhauster as a Draft Producer

The efficiency of the turbo-exhauster as a producer of draft is the combined efficiency of the steam-turbine and the exhaust-fan. The steam-turbine is a device of comparatively high mechanical efficiency, but the conditions of service in the front-end of a locomotive are variable, and very high efficiency is not to be expected. In my initial study of the matter I assumed an efficiency of 60 per cent for the turbine. The exhaust-fan, with its cinder trap, is necessarily a fan of low efficiency, and I accepted for it an efficiency of 40 per cent. Under these estimates, the combined efficiency is 24 per cent; that is, the turbo-

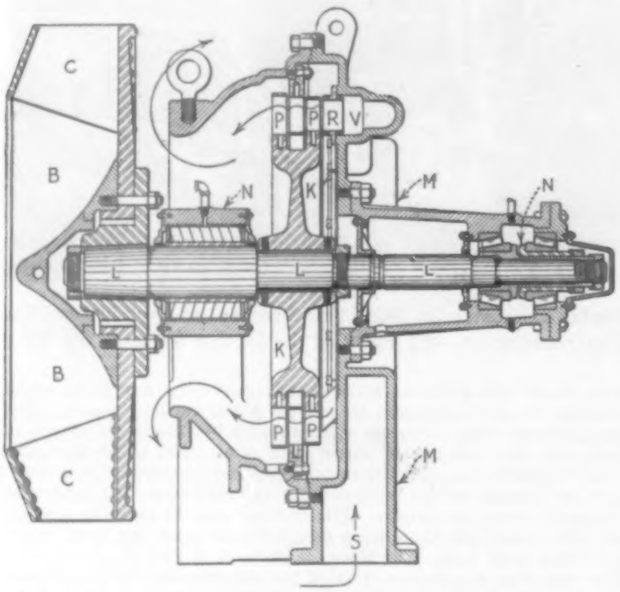
exhauster will return in useful draft effect substantially 25 per cent of the initial energy of the exhaust steam, which is to be compared with 8 per cent now obtained from the open exhaust-jet.

If we convert this increase in efficiency into reduction in back-pressure, by reference to a record of performance of the Mikado locomotive tested by Professor E. C. Schmidt, to which reference has already been made, the facts are as follows:

Comparison of Turbo-Exhauster with Normal Locomotive

		Medium power	Heavy power
	Results of Tests—Normal Locomotive		
(a)	Lb. of coal per hour	2,900.0	6,600.0
(b)	Lb.of steam per hour	23,000.0	42,000.0
(c)	Pressure of exhaust, lb	2.0	12.0
(d)	Draft, in. of water	2.4	7.0
	Results Available by Use of Turbo-Exhauster		
(e)	Pressure of exhaust, lb	.85	3.4
(f)	Reduction in pressure exhaust, lb	1.15	8.6
(g)	Reduction in pressure of exhaust, percentage of Item c	57.0	72.0

These values representing the possible performance of the turbo-exhauster as a draft producer are based upon an assumed performance of the turbine and fan. They have been confirmed in general terms by the performance of experimental equipment in service on the road. It has been shown experimentally that the turbo-exhauster easily supplies all the draft needed, on a back-pressure which is less than half that now employed. Obviously there are great possibilities in this direction, which await the introduction of a more highly perfected design of turbine and fan.



A Vertical Section of an Experimental Turbo-Exhauster

Accepting for the present a reduction of 60 per cent in pressure of exhaust of our prseent day locomotive, it follows that the turbo-exhauster will save from five to twelve per cent of the steam now used, the precise amount depending upon running conditions. Since, in locomotive service, economy in the use of steam can always be transformed into increase of power, it may be said that the turbo-exhauster, when applied to a modern locomotive, becomes a power booster, to the extent of from 200 to 400 hp.

The Turbo-Exhauster as a Muffler

One effect of the higher efficiency of the turbo-exhauster as compared with the open exhaust-jet now used is a complete elimination of all noise of exhaust. Experience has shown that a two-stage turbine wheel completely silences the exhaust of cylinders and air pumps and the roar of the blower-jet. Regarded merely as a muffler, the turbo-exhauster, unlike most mufflers, does not impede discharge, but actually brings about a reduction of pressure in the energizing stream.

The time has come when the designing engineer cannot be content with any device, however convenient or serviceable, the action of which results in unnecessary noise. The cost of noise in dollars, and in human lives is large, and a modification in design which will permit a steam locomotive to approach the electric locomotive in quietness of operation is in itself worthy of attention.

Effect on Spark Discharges

The discharge of solids from locomotive stacks has thus far refused to be suppressed. It is not that the solids cannot be separated from the gases, but that when separated, they cannot be gotten out of the front end, which, when the locoomotive is operating, is always below atmospheric pressure. There have been many attempts to provide a side-door for their orderly exist, but they would never use the door; they have always insisted upon passing out through the broad avenue by which everything else finds its exit from the front-end.

In this matter the introduction of the turbo-exhauster brings about a complete change. The solids entrained by the gases are collected in an intercepting ring-collector on the discharge side of the fan, where the fan pressure is maximum, and hence always above the pressure of the atmosphere. All solids thus collected are discharged by a separate pipe, preferably into the fire-box though, if the operator prefers, there is nothing to prevent their being delivered to the ash-pan or upon the road-bed.

This apparently easy disposal of the solids is due entirely to the fact that they are collected in a zone which is always at a higher pressure than that of the atmosphere. All that needs to be done to get them out of mechanism is to provide an outlet through which they may pass.

It is evident that the turbo-exhauster, by returning to the fire-box the solids which now pass out of the stack, is to be credited with such gain in the efficiency and power of the locomotive as a whole as may accrue from such action. Under present conditions of stoker firing, the effect upon output of power is complex, and I have not attempted to analyze it, but its effect upon fuel consumption cannot, I think, be questioned. The tests of fuel in locomotive service to which I have already referred†, show that with mine-run coal at medium power, 3 per cent, and at heavy power, 9 per cent, of the heating value of the fuel fire was discharged from the stack. There seems to be no doubt that a device which will return to the firebox the fuels thus discharged will recover these percentages of fuel.

Again the discharge of solids from the stack constitutes one of the serious objections to the presence in congested communities of the modern steam locomotive. The abatement of all such discharges, even if no use is made of their fuel value, represents a very potent advantage to be derived from the use of turbo-exhauster.

Tests of the Turbo-Exhauster

Steps have been taken to advance the state of the art represented by the turbo-exhauster. The theory of the device has been re-examined, model forms of exhaust-fans and cinder traps have been made and elaborately tested, and a series of full-sized turbo-exhausters have been installed and tested on a locomotive in road service. This work of design and testing, most skillfully conducted, has disclosed:

A complete confirmation of results predicted based on theoretical examination and analysis; that is, the device has done in service what the underlying theory said it would do.

That its use facilitates the process of firing up a locomotive.

That it supplies the requisite draft to make the locomotive steam satisfactorily in ordinary service.

That the back-pressure required to maintain satisfactory draft conditions is not more than half that normally required.

That the exhaust from the air-pump is sufficient to keep the fan turning when the throttle is closed.

That its use supplies the same element of balance between volume of steam delivered by the boiler, and force of draft controlling volume of steam produced, as is given by the open exhaust tip.

That in case of low steam-pressure on the road, the blower nozzle can be effectively used when the throttle is open, the blower supplementing the exhaust.

That the noise of the exhaust from the cylinders, from the air pump, and from the blower, is eliminated.

That objectionable cloud characteristics of the smoke discharge from the stack are diminished.

That the discharge of solids from the stack is reduced to an amount that is negligible.

It is but fair to add that the service tests developed two sources of difficulty, that the line of solution is in each case apparent but that the solution has not yet been worked out in service. The difficulties and the means by which it will be sought to overcome them are as follows:

The fan wheel suffered severely from the abrasive action of the solids entrained by the gases it was required to handle. The first fan put in service failed after a few hundred locomotive miles; a later fan tested withstood service for five thousand locomotive miles. The service requires a fan-wheel which can be depended upon for at least 25,000 miles. It is proposed to secure such a wheel by progress along three different lines, thus:

1—By making the fan-wheel respond more nearly to smoother stream lines, and to improve the character of material from which the fan-wheel is made.

2—By making certain parts of the fan-wheel heavier.

3—By reducing the work upon the fan-wheel by applying to the intake tube a series of inside spiral fins, so designed as to give the approaching gases, with their burden of entrained solids, a whirl in the direction of the fan-wheel's motion, in order that the blades of the fan-wheel will not alone be required to produce rotary motion in the gases and the entrained solids. As abrasive action diminshes rapidly with reductions in velocity of impact, even slight reductions in this velocity will serve greatly to prolong the life of the fan-wheel.

The efficiency of the turbo diminished under service conditions as a result of the accumulation of oil from the exhaust on its blades. Such acumulation was found to require attention at intervals of approximately 2,000 locomotive miles. It is obvious that the necessity for such attention would be entirely overcome if it should be found possible to introduce an oil separator in the exhaust-pipe connection, and there is a probability that such a solution can be had. In the event that it is not practicable to so separate the oil from the exhaust of the locomotive, it will be entirely practicable to inject into the turbine, at proper intervals, a solvent which can be depended upon to dissolve the encrustation.

The tests having been entered upon for a distinct purpose which did not necessarily involve the complete experimental development of the turbo-exhauster, were terminated when the purpose for which they had been undertaken had been accomplished.

Discussion

Dr. Goss was paid high tribute because of his long and continued interest in and helpfulness to the association and the mechanical departments of the railways.

Report of Committee on Electric Rolling Stock

L. K. Sillcox
Chairman

The 1927 report of the committee on electric rolling stock is usually comprehensive and embraces a variety of subjects. It is presented herewith in outline, special attention being given to information concerning operating results of existing electrified roads.

Lateral Forces Acting Upon a Locomotive When Passing Through a Curve

During the past year, the committee has conducted its studies in regard to the height of the center of gravity of electric locomotives and of variable resistance trucks. A large amount of data has been assembled pertaining to both subjects but only that concerning variable resistance trucks has been prepared for report. The data relative to the subject of variable resistance trucks appears in the form of an instructive and thoroughly prepared paper presented by A. Kearney, superintendent motive power, Norfolk & Western. The paper is highly technical and the conclusions are based on a general analysis of especial interest. They are as follows:

1—When a locomotive is running without exerting tractive effort, except for its own movement, the lateral resistance in the leading truck should be relatively large and the lateral resistance in the trailing truck should be zero.

2—Since the primary object of the locomotive is to haul cars, and the physical characteristics of the roadway vary between certain rather definite limitations, the locomotive design might best be a good compromise for the variation in operating conditions, consideration being given to the effect upon lateral forces for the various conditions of draw-bar pull encountered.

3—An analytical study is of value towards interpreting the results of experimental study and observation, and in estimating, in a general way, the results that might be expected from certain features in design.

4—A satisfactory locomotive would seem to be one which will traverse curves with freedom and without cramping or localizing stresses, and without excessive wear and punishment to detail parts of track and machinery.

5—Rail and flange wear are factors by which some of the qualities of a locomotive design might be judged and that rail and flange wear are closely related to track stresses, although it does not seem possible to definitely measure the varying track stresses and yielding of track, and therefore to calculate with a degree of certainty the amount of rail and flange wear.

6—A high lateral resistance is desirable in the front truck and a low lateral resistance in the trailing truck. Although, when the locomotive is called upon to do practically as much work in one direction as in the other, an ideal condition might be obtained by reversing or exchanging the characteristics of the leading and trailing trucks.

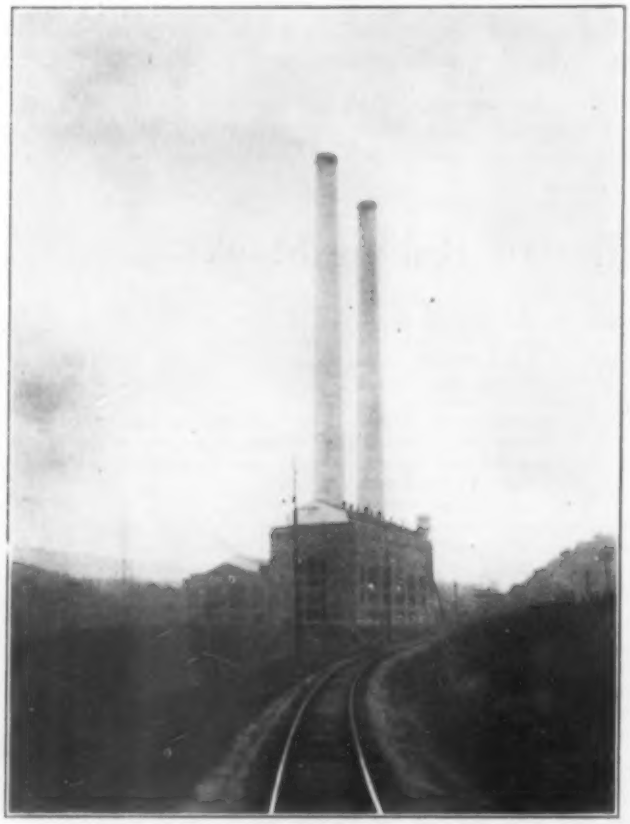
7—Those associated with the operation of electric locomotives which are run practically as much in one direction as in the other—might with profit observe the rate of flange wear, tire and rail wear and all the factors which might have contributed to unsought conditions and from which observations more accurate determination might be made for the most economical apportionment of wear between the various elements for the peculiar or local conditions.

In the appendix, brief reference is made to some practices in locomotive design as well as to some features of design which have been proposed in connection with the lateral resistance of leading and trailing trucks on heavy electric locomotives.

After analyzing the situation, the committee has reached the conclusion that the figures as reported to the Interstate Com-

Two-Unit Electric Locomotive and Freight Train on the Detroit, Toledo & Ironton

merce Commission are not adaptable to the purpose of comparison of operating data on electric rolling stock between various roads, although suitable for the purpose for which it is intended. The report further states that it is desirable to have the electric locomotive ratings included in the data annually collected by this committee and included in their report, prepared on the same basis for each road if possible; and it is therefore the recommendation of the committee that this subject be given further consideration next year, with a view to establishing a standard method of reporting electric locomotive ratings for the A. R. A. report.



The Virginian Power Plant at Narrows, Va.

Standard System of Nomenclature for Electric Locomotives

The point of special interest in the report of the sub-committee on nomenclature is that the "Standard" system of nomenclature for axle and truck arrangement of electric locomotives be adopted. This recommendation is made in accordance with practice of American manufacturers and is used by the manufacturers because the Whyte system has limits with regard to electric locomotives which makes its use undesirable. There are electric locomotive wheel arrangements which cannot be designated by the Whyte system. A locomotive which has a wheel arrangement 2-6-2+2-6-2+2-6-2 according to the Whyte system is designated as 3 (1-C-1) by the Standard system. The Standard system was described in detail in an article published in the February 27, 1926, issue of the *Railway Age*.

Detroit, Toledo & Ironton Electrification

The section of the report devoted to the D. T. & I. was prepared by F. L. Rockelman, vice president and general manager. The power supply, catenary system and motor generator type locomotives are described. The electrification includes 17 miles of double track line between Fordson and Flat Rock, Mich. On the basis of a year of successful operation, Mr. Rockelman makes the following comments:

"The two motive power units working as independent units completed a total of over 70,000 miles in service during the first year's operation and have had an availability factor of virtually 100 percent.

"A single unit has handled a maximum train of 137 cars with an estimated tonnage of over 6,000 tons.

"One of the interesting features of this operation is the maintenance procedure followed. A special maintenance force has not been built up and the regular locomotive operators consisting of engineers and helpers are used to maintain the locomotives they run. This procedure has been made possible due to the small amount of maintenance actually required. Also, another interesting development has been the relatively large amount of time the operators avail themselves of the regenerative feature of the locomotive to slow down trains.

"During the trip between Fordson and Flat Rock, three other main line railroads are crossed, i. e. the Michigan Central, Wabash and the Pennsylvania, and practically every trip it is necessary either to stop or slow down at one or more of these crossings.

"During steam operation prior to the electrification it was customary to use air on the train in the majority of such cases with loss in time.

"Since the electric units have been put in service nearly all slow downs or stops are made with regenerative braking. Hence, if a clear signal is given just as or just before the train has stopped, the train can be immediately accelerated without any loss of time.

"The flexible control provided by the locomotive has enabled the trains to be handled with practically no injury to the equipment whatever and not a single drawbar has been charged against the electric locomotives since the service was inaugurated.

"Plans are under way for additional locomotives and extension of the electrification."

Virginian Electrification

Last year's report of the committee included a paper by J. W. Sasser, superintendent motive power, Virginian, which dealt with the various phases of the Virginian electrification. In this report, Mr. Sasser supplements the information presented a year ago. This additional information is brief but of particular value because of the operating data it contains and with the exception of three power plant load curves, is published herewith complete as follows:

In last year's report on the Virginian electrification, a general description was given and operation of the Mullens-Princeton section was described. Since that time, the remaining section extending to Roanoke, Va., has been completed and operation inaugurated the middle of September, 1926. As indicated in last year's report, trains were made up to 9,000 tons at Clarks Gap, and handled to Princeton by one locomotive. On September 18, 1926, the first train left Clarks Gap for Roanoke with full tonnage of 9,000 tons, returning west the same day, with a train of approximately 2,800 tons of empties. Operation through to Roanoke has proved successful, regeneration being taken care of to the full capacity of the locomotive. In the run of 118 miles from Clarks Gap to Roanoke, the 9,000-ton trains are handled at the 28-mile-an-hour speed for approximately 45 miles, and at 14 miles per hour for the remainder of the run. There is only one regular stop, arranged for the inspection of trains, at Whitethorne, and runs are frequently made with only this one stop.

In operation through to Roanoke with electric power, the practice of making up eastward trains at Princeton, and the pusher service maintained under steam operation at Whitethorne, have been discontinued, with considerable saving in time and expense. Westward trains of empties are stopped at Princeton for inspection, the electric locomotive leaving its train at this point, picking up the previous train inspected and proceeding to Elmore.

Since operation through to Roanoke has obtained, the Virginian experienced in the months of October and November, 1926, the heaviest business in its existence. During the month of October, 211,420,600 gross ton miles represented the work done by electric locomotives, while in November, the figure reached 213,545,860. The average locomotive mileage per day for 3-cab locomotives for the month of October was 139.1, and for November, 147.6. In considering this figure of average locomotive mileage per day, the fact should not be lost sight of that more than 50 per cent of the locomotives were used on short runs and hill service, including pusher service, and that all the locomotives owned were considered in the above average mileage, whether in service or in terminals for any reason. Individual locomotives operating in the 135 mile run between Mullens and Roanoke greatly exceeded the above average mileage, the daily mileage frequently being in the neighborhood of 270 miles. The locomotives have stood up remarkably well in service. One maintenance feature of particular general interest is the success of the floating bushings applied to the main and side rods. Up to the end of December, 1926, only one floating bushing was removed; and judging from results already obtained, it does not appear improbable that an average life of 60,000 miles will be obtained from these bushings.

Locomotive maintenance costs are often figured in cost per locomotive mile, but a comparison of this nature is of little value unless similar locomotives operating over an identical profile are being compared. Furthermore, the number of units per locomotive varies. However, following this system, the cost of electric locomotive repairs is 9.8 cents per unit mile for October and November, 1926, and 13.6 cents per unit mile from January 1 to November 30, 1926. When prorated to 100 tons on locomotive drivers these figures become 6.4 cents and 8.8 cents, respectively. Even this, however, is not a satisfactory basis for comparing locomotive maintenance costs, and some other measure should be employed to indicate the cost on the basis of work done by the locomotive. In the case of the Virginian locomotives, which are equipped with watt hour meters, this can readily be ascertained by taking the total energy in kilowatt hours used by the locomotives both for motoring and regenerating, which is a very close measure of the work done, and dividing this into the total repair cost. The cost so obtained is 1.3 mills per kw.-hr. used, for the months of October and November, 1926, and 1.27 mills per kw.-hr. used from January 1 to November 30, 1926. The cost of electric locomotive repairs of other roads on this basis is not now readily available for comparison, but it is hoped that the practice of keeping the record in this way will be encouraged.

Brief reference has been made in the previous report to the Narrows Power Plant; practically all that remains to be said is that experience has justified the used of pulverized fuel as being well suited for handling the sudden load changes inherent to Virginian Railway traffic conditions. Until the electrification was completed and the power plant operated under the load conditions for which it was designed, the coal consumption was unavoidably high, but for the months of October and November, it averaged 1.66 lb. per kw.-hr. During this period the load factor was 52 percent, with an average power factor of 85 percent, based on the total output of the generators obtained from the actual hours run during this period compared with their rated capacity.

The cost of producing power, including fuel, operation of power plant, and maintenance of power plant, substations, transmission line, distribution system and track bonding, for the ten months ending October 31, 1926, was 4.388 mills per kw.-hr. produced at the power plant. During October and November, when the increased and better load, due to operation through to Roanoke, was experienced, the cost per kw.-hr. was 3.401 mills and 3.787 mills, respectively.

During the month of November, 1926, the maximum output was reached, figures of some interest being shown in the following table:

Energy generated, total for month	11,212,000 kw.-hr.
Energy generated, net for month	10,719,100 kw.-hr.
Energy generated, total maximum day	441,000 kw.-hr.
Energy generated, net maximum day	423,600 kw.-hr.
Maximum: Instantaneous load for month (3 generators on line)	47,000 kw.-hr.
Maximum: 5-minute load for month (3 generators on line)	42,000 kw.-hr.
Maximum hour load for month (3 generators on line)	31,000 kw.-hr.

An interesting feature of the power supply is that supplied by the locomotives themselves, through regeneration as referred to in the previous report. During the two months under consideration, it was demonstrated that practically all of regenerated power is being absorbed by other locomotives, the water rheostats at Narrows power plant very seldom coming into operation. This is a real factor in operation, as 8.3 percent of the total power consumed by electric locomotives while motoring during this period was supplied by regeneration.

An inspection shed has been installed at Roanoke, Va., to take care of inspection and minor repairs, lubrication, etc., the locomotive being prepared for the return trip in a minimum time, averaging two hours. All ordinary maintenance and heavy repairs are made at Mullens and fifteen months of operation have demonstrated that the shop facilities specially provided for electric locomotives at that point have justified the design and capital outlay.

The transmission, distribution, and catenary systems were described in the previous report, and nothing much can be added to that statement, other than that no serious defects have developed and the general arrangement has been found to meet the requirements of operation.

As stated above, the business handled by the Virginian during 1926 exceeded all previous experience, and, during the two months mentioned, placed upon the electrification a demand closely approximating, if not exceeding, the traffic on which the number of locomotives provided was based. The Virginian feels, from results obtained, that electrification through its mountain division has proved a success and has justified the capital outlay.

The Vollmer Road Substation, Illinois Central, Chicago Suburban Electrification

Illinois Central Electrification

During the year covered by this report, the Illinois Central has inaugurated electrical service on its suburban lines in Chicago. This project is notable in the high motor capacity provided per unit of train weight in order to permit high rates of acceleration. There are many other interesting features involved and to make these available to members of the association, the committee invited E. W. Jansen, electrical engineer, Illinois Central, to prepare a paper covering this most recent project. The report by Mr. Jansen includes the history leading up to the electrification, some operating results and brief descriptions of the supply system; the supervisory remote control; a.c. light and power service; inspection and repair shops; heavy inspection shop; multiple unit cars; motors, control, and auxiliary equipment; instructions for train employees. That part of the report which deals with operation results is included in the following:

In 1922 a commission was appointed to make a study of the type of system best suited for the Illinois Central suburban electrification, four different voltages being considered, with the reuslt that a 1,500 volt, direct current system, with overhead catenary system of construction to deliver current to the cars and locomotives, was decided on, on the basis that it was a Terminal Electrification only.

Suburban service covers the following tracks on the main line south:

Randolph street to Eleventh street, 1.3 miles, two main tracks and one equipment lead.
Eleventh street to Fifty-first street, 4.9 miles, six main tracks.

Table I—Steam and Electric Schedules for Matteson Trains

Distance from Randolph st. to Matteson is 27.93 Miles

	Steam schedules (1925)		Electric schedule requirements			Electric schedule actually obtained		
	Intermediate stops	Schedule time in minutes	No. of intermediate stops	Schedule time in minutes	Per cent decrease in time electric vs. steam	No. of intermediate stops	Schedule time in minutes	Per cent decrease electric vs. steam
Local	34	80.0	33	72.5	9.4	*36	68.5	14.4
Express	25	79.0	25	63.5	19.6	*28	64.7	18.1
Special	14	64.5	13	53.0	17.8	*15	53.0	17.8
Golf special	9	60.0	8	46.0	23.3	8	45.7	23.8

*A short time previous to starting electric operation, the station stops were increased to the number shown.

Fifty-first street to One Hundred and Fifteenth street (Kensington), 8.1 miles, four main tracks.

One Hundred and Fifteenth street to Matteson, 13.7 miles, two main tracks.

In addition there is a branch line to South Chicago consisting of 4.5 miles of double track connecting with the main line at Sixty-seventh street, and a single track branch line from Kensington (One Hundred and Fifteenth street) to Blue Island, 4.4 miles. The Chicago, South Shore and South Bend, which changed from 6,600 volts a. c. to 1,500 volts d. c. in 1926, operates hourly trains from Randolph street to Michigan City and South Bend with 30 minutes service between Randolph street and Gary, these trains connecting with the Illinois Central at Kensington. The double track portion of that line from Kensington to the Illinois-Indiana State Line, 6.5 miles, is owned by the Illinois Central and leased to the C. S. S. & S. B.

Map of Electrified Sections, Illinois Central Railroad

A decrease of from 10 to 24 per cent, depending on number and location of intermediate stops has been made with the electric trains as compared with former steam operation, there now being 475 scheduled trains week days, including trains of the C. S. S. & S. B., operating between Kensington and Randolph street. Train miles at present are about 214,000 per month, with about 855,000 car miles. In January, 5,442,041 traction kw.-hr. were used including C. S. S. & S. B., the maximum demand was 20,104 kw., or 6.36 kw. per car mile, including heating.

The construction of the cars began in August, 1925. The overhead catenary system was started August 3, 1925, but did not reach full headway until October 1. The first revenue trains were operated July 21, 1926, between Randolph street and Sixty-seventh street on local tracks. A formal opening of the service was made on August 7, and the complete service was placed in electric operation on September 1, 1926, or about six months in advance of the time required by the ordinance. At the present time 260 cars are in service, operating in two-car units, there being 130 motor cars and 130 trailers, a motor car and trailer being semi-permanently coupled and operating as a unit. These cars operate in local, express and special service. Local trains make stops on an average of 0.6 miles. Express trains 5.8 miles in length, followed by local runs or an average of 1.0 mile between stops. Special trains average 1.7 miles between station stops, but on some runs there is from 5.8 to 14 miles between stops.

After considerable study, an acceleration rate of 1.5 miles per hour per second, with a balancing speed of 57 miles per hour and braking rate of 1.75 miles, per hour, per second, was decided upon. In actual service a speed of 65 miles per hour is frequently attained. The motor cars are equipped with four 250 horsepower motors, giving 500 horsepower for each car in the train.

Twenty Years' Electrical Operation on the New York, New Haven and Hartford

This year marks the twentieth anniversary of electrical operation on the New York, New Haven & Hartford, and as a part of this report W. L. Bean, mechanical manager, New York, New Haven & Hartford, has presented a history of the experience of the New Haven with electric motive power. More electric traction history has been made on the New Haven than on any other road and in this report Mr. Bean presents this history in a form invaluable to the student of electric traction and to the prospective user. Only that part of the report which concerns operating results is included in the following:

The electric zone of the New York, New Haven & Hartford Railroad consists of the following:

Woodlawn, N. Y., to Cedar Hill, Conn.	4 tracks	63 route miles
Harlem River, N. Y., to New Rochelle, N. Y.	6 tracks	12 route miles
Oak Point, N. Y., to Fresh Pond Jct., L. I.	2 tracks	8 route miles
Stamford, Conn., to New Canaan, Conn.	1 track	8 route miles
So. Norwalk, Conn., to Danbury, Conn.	1 track	24 route miles
*West Farms, N. Y., to Mt. Vernon	4 tracks	6 route miles
*Mt. Vernon to White Plains	2 tracks	8 route miles
*Mt. Vernon to Harrison	2 tracks	6 route miles

*Operated by New York, Westchester & Boston.

Through passenger traffic is handled between Grand Central Station and New Haven, and between Sunnyside, Long Island (Pennsylvania connection to Pennsylvania Station) via the Hell Gate bridge route and New Haven.

Commuter service is handled from Grand Central Terminal to New Rochelle, Port Chester and Stamford principally by multiple unit car trains arranged to give local and express service.

The local service on the Harlem River, New Canaan and Danbury branches is also handled by multiple unit trains.

Local passenger and freight traffic and service to New York is handled on the New Canaan and Danbury branches.

The Line from Oak Point to Fresh Pond handles freight only. At Fresh Pond the electrification will continue later in 1927 to Bay Ridge over the Long Island's line. Freight trains will then be handled between Bay Ridge and Cedar Hill, Conn., a distance of 88 miles. The present electric movement of freight trains is between Oak Point and Cedar Hill, a distance of 68 miles. This route is one of the two principal western gateways for freight for the New Haven.

The New York, Westchester and Boston, a subsidiary of the New Haven, separately operated, handles commuter service between Harlem River, the Bronx, Mt. Vernon, White Plains, New Rochelle and intervening stations to Harrison. Construction to Port Chester will ensue at an early date.

Local freight service on the Westchester is handled by an electric locomotive.

Mileage Performance of Equipment

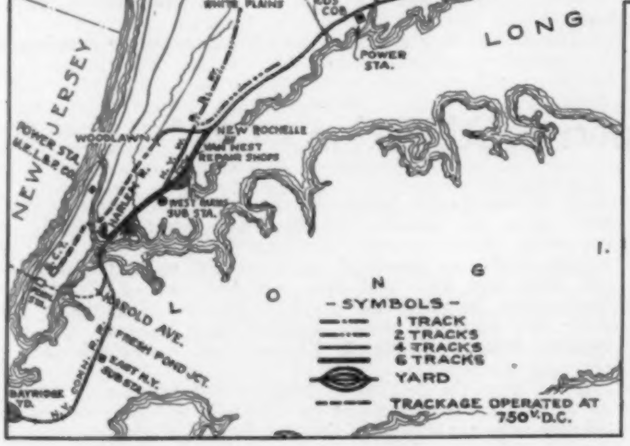
Forty-one passenger locomotives of the earlier type have been in service twenty years. The average for each serviceable locomotive is 170 miles a day and the total mileage per locomotive of this type has reached about a million and a quarter miles. After this remarkable mileage these engines still handle most important main line fast trains, which record as to locomotive age, mileage and character of service, is unquestionably not equaled in steam service anywhere.

The latest type of passenger locomotive, known as the 0300

class (22 of which will soon be in service and 5 on order) have averaged nearly 250 miles a day, and during the past year several of these engines have made nearly 100,000 miles. It is not unusual for one locomotive to make between 400 and 500 miles in 24 hours even though the longest run is only 73 miles. One engine made as high as 11,000 miles in one month.

Electric passenger locomotives made 377,000 miles in October, 1926, or 214 miles per serviceable locomotive per day. The average locomotive mileage per day for all serviceable freight locomotives is 150. Electric switching locomotives have records of 4,300 to 4,500 miles monthly, and are kept in service twenty-four hours a day for as many as thirty days continuously.

It is not unusual for an electric freight locomotive to make a round trip from Oak Poiht to Cedar Hill, 138 miles, in six hours, which makes possible two round trips per day for these engines. The freight locomotives average about 160,000,000 ton miles of freight per month at an average train speed of about 18 miles per hour. This reqqires around 125,000 freight-locomotive-miles per month, or 150 miles per locomotive per day, for serviceable engines. The 36 freight locomotives which were placed in service in 1912 and 1913 have now averaged nearly a half million miles for each engine, the present average yearly mileage being 46,000 miles, for the total number of engines of this class owned. A maximum month recently showed nearly 6,000 miles for an engine of this type. In the same month, electric motor cars made over 126,000 miles, or 97 miles per day for all cars in service.

Map of Alternating Current Electrified Zone, New York, New Haven & Hartford

Passenger Traffic Handled in the Electric Zone

The passenger service, handled by locomotives for the express trains and local express trains and multiple-unit cars for the local commuting service, involves very dense passenger traffic. The New Haven Railroad brings to its passenger terminals in New York City approximately 28,000 passengers daily, and about one-half of this passenger traffic is handled during the two-hour rush period night and morning. In 1925, 18,000,000 people were handled into Grand Central Terminal.

The "fleet" movement of trains carrying commuters into New York from Connecticut and the nearby New York State points, increases in density approaching New York, as one suburban zone after another is entered. At Stamford, Port Chester and New Rochelle, train movements are added. Between Stamford and Mount Vernon there are fourteen stations in a distance of nineteen miles, generally located in centers of considerable population. The accumulation of passenger load and additional trains causes an extremely dense traffic reaching its peak at New Rochelle Junction. At this point, where the 6-track Harlem River branch leaves the main line, 261 trains and 3,483 cars pass during a normal 24-hour period. There have been as many as thirty trains in one hour through this junction.

The New York, Westchester & Boston Railroad, a subsidiary of the New Haven Road, handles suburban traffic between White Plains and Mamaroneck to Harlem River, where connection is made with the Interborough Rapid Transit lines. This road is now extending its line parallel to the New Haven system to Port Chester, N. Y. It takes care of a very large commuting traffic and maintains a schedule, very convenient to the suburban district, of two trains every twenty minues in and out of New York throughout the day. The multiple-unit cars handling this service are equipped with the same single-phase motor used on the New Haven equipment.

Exclusive of the New York, Westchester & Boston, the New Haven handles approximately 350,000 passenger locomotive miles monthly and 100,000 passenger motor car miles.

Of every thirteen passengers riding on standard railroads in this country, one rides on the New Haven, and one out of every nine passengers riding on commutation tickets also uses the New Haven.

The New Haven has the heaviest main line traffic of any electrified railroad of its length in the world.

Freight Traffic

The freight service on the electric zone extends from Oak Point and Harlem River yards to the Cedar Hill classification yard, just east of New Haven. Freight is also received from the Pennsylvania at Bay Ridge, L. I., and at present it is moved by steam locomotives to Oak Point, over the Long Island and New York Connecting Railroad. The electrification of this route is now under construction with the expectation it will be completed by July 1, 1927. The through traffic will be handled by the New Haven.

The Long Island has just received fourteen 11,000 volt locomotives which will be used in float, yard and transfer service in the Bay Ridge yards. This electrification will assist train movement through the tunnel in East New York.

The New Haven Railroad receives daily approximately 950 freight cars from its connections on the Jersey Shore and forwards some 1,100 cars per day eastward. As many as 16 trains totaling 813 loaded freight cars have been started eastward from Oak Point yards in six hours. This yard at Oak Point is the largest electrified yard in the world, having 35 track miles equipped with overhead wire. In October, 1926, 179,076,000 ton miles of freight were moved by electric locomotives with an average train speed of 17.18 miles per hour.

Switching Service

Electric switching service is maintained at the Harlem River terminal yards and several other yards between those points and Stamford. The service required of these engines consists of pulling and loading floats which interchange freight with the Jersey Shore (this being extremely heavy duty under certain conditions of tide and load) as well as the classification of trains and other terminal yard work, and use as a helper engine on

the 1.2 per cent grade of the Hell Gate Bridge for westbound freight trains to the Bay Ridge yard.

Three of these switching locomotives, in multiple, have been tried out in humping service in the Cedar Hill classification yard. Their performance is considered very satisfactory. The steady uniform torque of the electric locomotive is specially suitable for tipping the cars over the hump one at a time at regular intervals and at the desired speed. The 16 original switcher locomotives with single-phase motors, have been in service about 14 years and have made an average of 492,000 miles each, or a yearly average of around 37,000 miles for all engines of this type. Six more switcher locomotives similar to the original 16 are now being built and will soon be in service.

Inspection and Repair Program

The locomotives are given periodic inspection between 2,500 and 3,000 miles, the multiple unit cars between 2,000 and 2,500, while the trailers are given inspection once every three months.

All repairs are now made on a mileage basis which has been carefully worked out for each class of equipment in accord with experience gained during the last twenty years of operation. Depending on the extent of the work to be done, the repair job falls into one of the five classifications. The classifications are so arranged that a second, third or other periodic shopping registers with the time for general overhaul. For instance, on the latest class passenger locomotives this works out as follows:

Mileage	Class of repairs
At 55,000	4
At 110,000	3
At 165,000	4
At 220,000	3
At 275,000	4
At 330,000	2

The classification of repairs are :

Number 1—(a) Rebuilding locomotive or car, replacing or relocating apparatus on a major scale, involving large amount of work and expense.

(b) Extensive repairs or replacements made necessary by accident or fire.

Number 2—Periodic general overhaul of all mechanical and electrical apparatus, and the painting of interior and exterior.

Number 3—Heavy truck overhaul, turning tires and commutators, and repairs to auxiliary and main electrical apparatus. Paint exterior.

Number 4—Minor truck overhaul, turning tires and commutators, and light repairs to auxiliary and main electrical apparatus.

Number 5—Running repairs made between regular scheduled mileage shoppings Nos. 1, 2, 3 and 4.

A careful record is kept of the mileage run and the extent of repairs made to each piece of equipment. A monthly statement is made up from this record showing the mileage run out of each class of power. From this the locomotives are scheduled for shopping and the maintenance program arranged. Records of the principal pieces of main and auxiliary apparatus are also kept for guidance in determining repairs required.

The work passing through the shop is inspected as parts are assembled in units, and as a whole when the locomotives are completed.

The above method of maintenance has been found profitable because the old adage "A stitch in time saves nine," holds very true for the electric locomotive.

Conclusions

The foregoing is intended to picture briefly the high spots of the history of the New Haven electrification and to give a measure of its character and extent.

It must be considered the project undertaken in 1907 was of great magnitude, and, in view of the then state of the art, required great courage.

Those who prescribed the earlier arrangements and who overcame the relatively few, but nevertheless annoying, physical difficulties leading to the splendid accomplishment which has resulted, are entitled to the fullest recognition of their technical abilities, their courage and their steadfastness in building what is in fact a monument to their skill and endeavors.

Is the result a success? If anyone doubts he should accept the invitation to delve into all the ramifications and complexities of the problem and especially to start by attempting to consider some other method of train propulsion (steam, most probably), which would give the same traffic capacity, reliability, safety, comfort, quietness, cleanliness and economies, all things considered as are being accomplished by electrification.

Electrification Progress

The committee concluded its report by outlining electrification progress made during the year both in the United States and abroad and by suggesting subjects for consideration during the coming year. The report is signed by L. K. Sillcox (chairman), Chicago, Milwaukee & St. Paul; G. C. Bishop, Long Island; W. L. Bean, New York, New Haven & Hartford; J. A. Carmody, New York Central; J. H. Davis, Baltimore & Ohio; A. Kearney, Norfolk & Western; J. V. B. Duer, Pennsylvania System; J. W. Sasser, Virginian, and E. W. Jansen, Illinois Central.

The report was accepted and the committee continued.

Report on Locomotive Utilization

T. B. Hamilton
Chairman

The development of the American railroads has made the utilization of locomotives a very important and necessary subject. The magnitude of investment in locomotives, character of facilities necessary for their maintenance and their preparation for service and the cost of actual repairs, have reached such proportions that railroad officers are directing much study and consideration to securing the maximum return from each locomotive consistent with maintenance expense.

To obtain data bearing upon this subject and to study locomotive utilization, maintenance and facilities on the ground under the various conditions, field surveys were made on the following railroad systems:

Union Pacific	Southern Pacific
Atchison, Topeka & Santa Fe	Florida East Coast
Louisville & Nashville	Missouri Pacific
Illinois Central	Chicago, Milwaukee & St. Paul
Pennsylvania	Northern Pacific
Baltimore & Ohio	Canadian National
New York Central	

These roads, covering a wide range of territory, operating conditions and traffic requirements gave your committee the fullest opportunity to study this subject. Detailed information covering surveys made is on file with the American Railway Association, Mechanical Division, and is available to executive officers of member roads.

The year 1926 was the greatest in the history of the railroads in the United States, freight traffic and operating revenues being the largest ever recorded, while practically all operating factors reached the highest point ever attained. Freight traffic as measured by gross ton miles increased 7.4 per cent over 1925 and 11.3 per cent over 1923, each of these years breaking all previous records of business handled; net ton-miles, which included both revenue and non-revenue tonnage, increased, 7.1 per cent over 1925 and 6.8 per cent over 1923.

Apart from the detailed explanation as to the larger capacity of the average active engine in service it will be observed the average miles per day per active freight and passenger locomotive for Class I railroads increased as follows:

	Freight	Passenger
1923	81.6	142.6
1924	79.1	143.0
1925	82.3	147.7
1926	85.0	151.9

During the year 1926, an average of 154.8 lb. of coal were required to haul 1,000 tons of freight and equipment, excluding locomotive and tender, a distance of one mile as against 158.9 lb. in 1925, a substantial decrease being recorded each year against the 1922 unit of 186.0 lb.

The number of miles per freight locomotive owned per day in 1926 averaged 61.8 compared with 58.3 for 1925, 55.3 for 1924, 60.3 for 1923 and 52.0 for 1922. In like manner on the basis of active locomotives. To fully comprehend what a great net improvement this is, we must bear in mind the increased work each locomotive is doing while increasing this mileage. Since 1922 the average road speed increased 7.2 per cent, gross tons per train increased 18.6 per cent and gross ton miles per train hour increased 27.9 per cent, and decreased the fuel consumed per 1,000 gross ton miles 16.8 per cent.

The percent of unserviceable freight locomotives owned also decreased to 16.4 per cent in 1926 compared with 17.8 per cent in 1925, 18.8 per cent in 1924, 21.6 per cent in 1923 and 25.5 per cent in 1922. While the gross tonnage handled in 1923 broke all records up to that time, 1926 exceeded this year by 11.3 per cent and at the same time recorded a decrease of 1,621 in the total number of freight locomotives on line compared with 1923.

Ideas of Good Performance Have Changed

On the whole, the extension of locomotive runs has greatly increased the average mileage per active locomotive. The extent of this increase, in most cases, has not been as pronounced as it should be, due to retaining too many classes or units of motive power in service. With proper attention as to assignment, selection and maintenance of the locomotive, it should be possible to materially increase the average monthly mileage over that made five or six years ago and on some divisions to practically double the mileage.

The committee finds instances of extended runs where all active locomotives in an assignment are regularly making 10,000 to 12,000 miles per month in passenger service and between 5,000 and 6,000 miles in freight service. Under these conditions, we find approximately 12 hours productive time per day and 12 hours non-productive time, the latter divided into eight hours mechanical time (time of arrival at the engine house until repairs are complete) and four hours transportation non-productive time.

Statistics for Supervising Utilization of Locomotives

In addition to those statistics necessary to cover the general record, operating cost and performance of power, a daily turning power report should be kept for the benefit of local and division supervisors which will show the movement and distribution of the non-revenue time of freight locomotives at terminals. This report should be kept at all terminals by 24-hour periods, showing in detail the movement and time required for such a cycle from the time the locomotive arrives at the terminal with the train until it departs from the terminal with the train. Reports should be in sufficient detail to give the local officer a complete check on terminal time so that corrective measures may be taken to reduce this time in any respect that it is found excessive. This report will indicate whether or not movements to or from the yard, over the ash pit, repair time, waiting train time, etc., are reasonable, and total terminal delay may very often be materially reduced by following up such information.

A special study should be made of the idle time locomotives are awaiting trains and the locomotive assignment maintained so this time will not be excessive. A daily record and reports should also be kept of the locomotives undergoing or awaiting heavy running repairs, certificate repairs and other engines held out of service 24 hours or longer. By carefully checking such power, the time out of service for such repairs may be reduced, the attention of proper authorities forcibly drawn to the needs of forces or facilities to more promptly handle such repairs, or setting up other corrective measures to return this power to service more promptly.

It is important also that a daily or a weekly expected mileage for freight locomotives be determined for each division as a mark to attain. Low mileage should be analyzed to determine if there is too much power in service.

All such reports must, of course, be accurately prepared and constantly used by local and division authorities if they are to be of value.

Dispatching of Locomotives and Trains

Close co-operation must be obtained between the transportation and mechanical department forces so that delays to engines at terminals may be reduced to a minimum. The scheduling of trains at a time of day when the least interference will be encountered is a matter of vital importance. The dispatching of trains en route over the division must be given careful thought to avoid every unnecessary stop.

Telephone dispatching, the elimination of as many train orders as possible and every efficient dispatching means known should be employed to reduce stops and delays to the lowest possible minimum.

As far as possible, locomotives made ready at terminals and the dispatching of trains from the terminals should be anticipated, by at least the crew calling time, in order that the time between repairs completed and the time the engine leaves the terminal may be reduced to a minimum.

The anticipation of power is of importance both to the maintenance forces in scheduling repair work and to the transportation department in scheduling departure of trains.

The operation of all freight trains extra, eliminating time table schedules, unquestionably expedites the movement both with respect to departure from terminals as well as to road movement. The length of blocks, whether automatic, manual or manually controlled systems, should be studied with a view of obtaining the fullest utilization possible and with the least interference.

Prior classification, solid blocking of freight for certain destinations, etc., should be given careful consideration and these features carried out to the greatest extent possible, thereby materially reducing yard work and switching at intermediate terminals as well as to reduce switching at final terminal in disposing of cars. Many railroads are confronted with unnecessary stopping of trains at crossings which could be avoided if automatic signals were furnished, thus keeping away from the possibility of mechanical failures as well as delays incident to slowing down, stopping and accelerating trains, to say nothing of added tonnage which might be hauled if it were unnecessary to stop for crossings. In addition, where trains have to be consolidated the movement should be comprehensively studied with a view to co-ordination at meeting points and dispatching, so as not to delay either motive power or cars unnecessarily.

It is thought that a study of the length of crew runs will reveal opportunities on many roads for an extension of the same, which, of course, should result in the elimination of unnecessary stops and delays to trains and, in many cases, to the lengthening of engine runs with the same crew.

A large part of the initial and final terminal delay is encountered in getting engines to and from the engine house and yard. The importance of reducing this delay to a minimum does not seem to be given the attention that it deserves. Close supervision of yard operation to eliminate lost time and delays to trains and locomotives arriving and leaving terminals is very important and tends to reduce delays to trains and lost engine hours.

Considerable improvement is in order at most yards in the utilization of yard locomotives. Apparently the full significance of lost time due to yard crews and engines working only a comparatively short part of their tour of duty is not appreciated by some yard organizations. At many yards where the operation is continuous, a great deal of saving may be accomplished by working engines of proper character 16 or 24 hours before being relieved and sent to the engine house, and in such cases, it is frequently economical to change engines in the yard by use of relief engines.

In the assembling of trains, consideration should be given to the importance of yard air testing plants where brakes are charged, tested and repairs made before outgoing engines arrive, in order to bring about a reduction in initial terminal delay. A competent and sufficient force of inspectors at dispatching terminals is essential in order to detect defects and make repairs prior to time train is scheduled to leave. A thorough inspection of all trains before the train is due to leave not only reduces initial terminal delay, but also eliminates the possibility of delays on road.

Tonnage ratings for locomotives should be established by the use of a dynamometer car or by careful practical tests. For the best results, it is, of course, essential that the locomotives be loaded to the maximum rating consistent with grades, weather conditions, character of traffic, roadway facilities, etc.

Local freight trains as a rule do not handle as much tonnage as is possible to handle with the type and size of locomotive frequently used in this service and there is an opportunity for an economy by loading local freight trains heavier. By so doing, in many cases, the necessity of through freight trains having to set off or pick up cars at intermediate points between terminals will be eliminated. There is also an opportunity in many instances to use the locomotive assigned to local freight service for a tour of duty in the yard or as a helper engine during its period of lay-over at the terminal and thereby in some instances eliminating the need for an assigned yard engine.

It has become the practice to measure the performance on the gross ton mile basis. It does not follow, however, that the greatest gross ton miles per train hour or per locomotive per day or month reflect the most economical performance, unless the proper balance is established and carried out between tonnage and speed. A train of light tonnage, operating at high speed, may produce as many gross ton miles per train hour as a full tonnage train moving at slower speed. It is important that proper relation between speed and tonnage be maintained over each division consistent with track conditions and traffic conditions and requirements. Except over some districts where it is necessary, for traffic reasons, to move comparatively light tonnage trains at high speeds, the most economical performance will be obtained by handling the greatest tonnage possible over the division within the schedule time allowed before running into overtime.

Terminal Facilities

Necessary terminal facilities are indispensable to prompt and thorough conditioning of locomotives and preparation for service. Special consideration should be given hot water boiler washing plants, engine-cleaning facilities, material storage and handling facilities; also the necessary crane and machine tool facilities dependent upon the nature or class of maintenance work to be handled at the engine house. It is very important that the storehouse and machine shop facilities be located either within or adjacent to the engine house proper. The following items of importance in an engine house layout should be given careful consideration:

Number and length of stalls.
Turn tables, proper length, power driven.
Proper heating and lighting, particularly natural daylight.
Firing up and blower systems.
Washout system.
Water lines.
Drop pit or drop table facilities.
Surface of engine house floors.
Smoke exhaust system.
Handling of work reports.
Power plant requirements.
Fuel and sand storage of sufficient capacity.

Your committee found considerable work being performed by both switch and road locomotives as a result of train yard facilities not being adequate for the volume of business handled. This results in additional yard time and expense in train preparation, as well as delays to road power. Adequate train yard facilities are necessary to secure the maximum work from each locomotive.

Locomotive Repairs

Classified or general repairs should be made on a mileage basis. By reason of extended locomotive runs and greater utilization of locomotives, class repairs will come at shorter periods of time, putting the locomotive into the shop where classified or extensive repairs may be made with less loss of time, at less cost to the locomotive and with improved condition of the locomotive during its term of service.

The committee's investigations indicate entirely too much loss of time for engines undergoing general or class repairs. It is extremely important in scheduling class repairs that a definite program be set up for at least three months ahead, and that care be exercised that locomotives are not bunched for shopping, either in total number or by class of engine or by class of repairs. Furthermore, when the locomotive reaches the three months period prior to shopping, careful inspection of engine should be made and all heavy or special materials that will be required be ordered.

Reduction in time necessary to make class repairs, as well as the fuller utilization of shop facilities, may be made in many shops by working two, or possibly three, tricks. At least a sufficient number of men should be placed upon second and third trick to do the stripping work on the locomotives, deliver parts for repairs and the completion of locomotives scheduled out.

For heavy running maintenance and monthly certificate repairs, as well as turn around repairs, best results are obtained by the monthly periodic inspection and repair method. At this time a thorough inspection and repair job should be done on the locomotive, putting it in condition to run to the next monthly period with a minimum of repair work and mechanical terminal delay, assigning repair forces where necessary so that this work may be carried on continuously throughout the 24 hours, thereby returning the locomotive to service with a minimum delay.

Every locomotive on a division or district should be assigned definitely to some terminal for maintenance and the responsibility for the condition of this locomotive to some designated officer.

The transportation officers are wholly responsible for getting the locomotive to the designated terminal on the date specified for monthly periodic attention, and it is vitally important that they co-operate with the mechanical department in this respect to obtain the best maintenance program. Furthermore, that between monthly inspection periods it is very important that transportation officers arrange to the greatest extent possible to have the long lay-over of power at the maintenance terminal, thus reducing the lay-over at the turn-around points to the minimum.

Considerable study is necessary in establishing extended locomotive runs which necessarily must give consideration to handling the maintenance work at points where it can be efficiently and promptly accomplished. On arranged service trains the schedule, to a large extent, governs the lay-over time at terminals, and it is important that this time be sufficient to make the necessary repairs without excessive transportation delay awaiting trains.

Influence of Equipment Failures Other Than Locomotive Failures

Delays in yards and on the line of road due to failures of car equipment, yard air line and testing plants, water facilities, signalling or interlocking facilities interfere with the fullest use of the locomotive. The car failures are by far the largest source of delays en route. Hot boxes, air brake failures, brake beam, truck and draft gear failures are altogether too numerous and frequently cause serious delays to trains getting over the road. It is, therefore, important that careful inspection be made of trains for car defects and that careful tests of brake equipment be made, particularly at dispatching terminals. With a properly organized inspection and repair force and with some small and properly located repair track facilities at such main dispatching terminals, many cars can be repaired promptly and continue through in trains that would otherwise be thrown out, resulting not only in delay to movement of car, but the whole train.

Locomotive Design

The design of a locomotive in all its detailed parts has a very decided bearing upon the possibilities of its utilization. The locomotive, with all appurtenances, should be carefully designed for the service required and the best of material used, with the thought of eliminating to the greatest degree possible running repair cost and delays.

Water for Locomotive Use

The committee feels that the matter of water treatment should be carefully considered and proper treatment given, as this has an important bearing upon the hours of service obtained from the locomotive. Almost any expense required to obtain the best water for locomotive use is justified. On some divisions where bad water exists or heavy treatment of the water is necessary the blowing down of boilers on line of road and at terminals within reasonable limits proves of considerable value in the preventing of foaming, accumulation of sludge and other locomotive troubles incident to foaming conditions, which result in road delay.

Fuel for Locomotives

It is the thought of this committee that the best performance from the fuel standpoint may be obtained by using the best grade of fuel available consistent with the cost. We feel, however, it is more important, and that better operation can be obtained as a whole, to use a uniform grade of fuel for a division, district or, if possible, for the entire road than by mixing various grades and qualities of fuel indiscriminately. While the uniform quality of coal used may be of low grade, better results can be obtained by using same and providing suitable grates and draft appliances than by using various quantities of coal in one territory.

The use of relatively low grade fuel or fuels high in ash does not in itself preclude the possibility of extended locomotive runs, as at crew changing terminals especially, provisions may and should be made for cleaning the fire and dumping ash pan where conditions make this necessary.

Economies to Be Effected

With a given assignment of power handling a given amount of business, an increase in the productive time of the locomotive naturally results in a corresponding decrease in the number of locomotives required.

The pooling of power is a sound economic principle and should be employed to the fullest extent by railroads on runs which, owing to inadequate roadside facilities, are not now in position to run through intermediate terminals. These terminals may be made "turn around" terminals and the monthly mileage greatly increased by reducing the lay-over to the minimum.

The observations of your committee convince us that improved operation and utilization of locomotives may be obtained on practically every road without the expenditure of heavy capital investment, and before heavy expenditures are made, the fullest use should be obtained of existing road and terminal facilities. The extension of locomotive runs in road service, the increasing of productive hours per day in yard service, the elimination, or at least partial elimination, of intermediate terminals and the consideration of the various phases of utilization touched upon in this report should be carefully studied, in order that the existing facilities may be utilized more nearly to their full capacity.

On roads or divisions where extended runs are not possible, considerable increase in productive time of locomotives and increase in miles per month may be obtained by establishing the maintenance point at terminals best equipped for mainte-

nance and making the other terminals simply turn-around points.

The report is signed by the following representatives of the Operating Division: T. B. Hamilton, Pennsylvania; J. T. Gillick, Chicago, Milwaukee & St. Paul, and A. E. Ruffer, Erie. Those representing the Mechanical Division are W. H. Flynn, New York Central; O. S. Jackson, Union Pacific, and O. A. Garber, Missouri Pacific.

Discussion

A. A. Raymond, New York Central: To get full service out of our engines, we have made some graphic charts of what results the engines were giving. The engines are running over two divisions and one of the interesting things was to know how many engines it took to support the serviceable engines. When we started in 1926 the mileage was about 200 a day, but that has gradually dropped down to about 180. It got below that but by publicity we were able to again increase it to 180 miles.

[The charts presented by Mr. Raymond show the fluctuations by months, each chart for a single class of locomotives, the miles per locomotive day, the number of serviceable engines, the number of stored engines, the number in roundhouse for repairs and the number held for shop repairs—Editor.]

Mr. Goodwin: If we have a run of 150 miles and extend it to 300 miles and do not have suitable facilities at the end to take care of these engines are we not going to find it difficult to make a success of such an extended run?

J. M. Nicholson, Santa Fe.: In establishing the extended locomotive run one of the first factors is the condition the locomotive should be in to make a trip of greater mileage. The extended run is more stringent than short run schedules. Another important thing is that fuel and water facilities be provided to get the locomotive over the territory with the minimum delay. The human element is another factor. Extension of locomotive runs brings the general pooling of power, and the men may not like the idea of giving up an engine. The men after accustoming themselves to the extended run invariably would not go back to the regular engine. The fact that they come into the station and give their engine up on a passenger run and take charge of their engine there has the advantage that they do not have to go to the roundhouse and prepare the engine which takes about 30 minutes more of their time. There is certain work that has to be done at intermediate terminals in the way of filling grease cups and lubricators. Larger capacity grease cups and lubricating fillers are reducing this work.

It is desirable to centralize maintenance work and rather than condition the engine to go from a terminal from which it is dispatched to another terminal, it can be and is conditioned on many railroads to run a round trip with the minimum attention at the end of the run. There are runs amounting to six or seven hundred miles where the engine is only given turn around attention in from three to eight hours.

Mr. Zwight: For years we had what might be called extended runs in passenger service but in freight, largely due to bad water and fuel conditions, we did not have them. Within the last two or three years we have extended not only our passenger, but our freight runs. Most of our passenger runs now cover what was formerly two or three. We have about six engines making the run from St. Paul to the Pacific Coast where we used to have about 13 or 14, and correspondingly in freight service. We thought because of taking the regular men off the engines that the mileage would be greatly reduced. That has not been true, probably because we set aside some of the less efficient engines and those that were harder to maintain. We have done well with our extended engine runs because of economy in maintainence in the mileage out of our better engines and in getting the co-operation of our men.

Mr. Purcell: We have found since we have started on the long runs a considerable decrease in our boiler maintenance for the reason that we formerly used the old method of cleaning our flues. We used to have from 300 to 500 failures of flues a year and I do not believe we exceed 100 or 200 now. While we do have a little more clinkering on long runs, we are able to get away with it on a certain class of coal. The long runs get away from the expansion and contraction customary with short runs. Flues, staybolts and boiler sheet failures are practically cut into two so far as the cost and number of failures are concerned.

Mr. Zwight: The type and the condition of the grate is one of the most important factors aside from keeping the firebox and flues tight. Years ago we did not consider the grates as much of a factor. We were forced to experiment with grates to burn a low grade of fuel and we necessarily had to reduce the air space opening to hold the coal on the grate. We experimented until we had reduced the air opening to about one-third of what it had formerly been and we found that this was the only grate we could use and burn the low grade of fuel. The round hole type of grate is what we have now but we have experimented in practically the same thing in slotted type and elongated openings. The conditions of the grates has more to do with keeping the fire and the engine in condition for a through run than any one thing, aside from the condition of the firebox and flues.

Mr. Demarest: The question of through runs and of expense is the old story again, namely the mileage per dispatchment which has been established, possibly through accident, by the location of intermediate terminals. What the operating people are trying to do is to get the greatest economies by making the through run force the elimination of the intermediate terminal. Extended runs produce economy in two ways. If properly applied they mean a reduction in capital and in running maintenance. The reduction in capital is only obtained if you reduce the number of engines performing the service. Otherwise the only savings are a little in maintenance and coal. From the analysis that has been made where there is any amount of business the through run may result in as high as 20 per cent reduction in the number of engines previously required.

One of the first things that you have got to look into in the establishment of through locomotive runs is whether the railroad has been built to accept the free movement of the engine over the long run. The coaling and water facilities have been developed on the basis of the older divisional points, perhaps on an average of about 100 miles apart. The through engine run frequently requires the installation of main line coaling stations and perhaps of track troughs. I have in mind one case of a through 468-mile passenger run. The engine itself went through without difficulty but it had to have intermediate coal and water. The location of the facilities was proper and it resulted in taking about fifteen minutes out of the schedule.

I have in mind another case, 463 miles, where the application of the through service is being delayed for the same reason. At the terminal where the engine passes through, it means a cutoff and a movement back to the enginehouse, which the schedule will not permit. With ordinary Indiana coal at least 300 miles is perfectly safe without intermediate facilities for cleaning the pans. The practice of giving intermediate attention by our engine crews has now become quite general. You cannot

ask them to do it, but by giving them a better engine, a cleaner engine and a more comfortable engine, you will find from the resulting psychological effect that they take an individual pride in the operation of the engine, and in getting through successfully. The outbound crew is down on the ground helping the inbound crew getting the engine ready as it stands at the passenger station.

The question of larger grease cups and the filling of the lubricator has also been discussed. I do not think we need the larger grease cups. It is not the amount of grease that you have but having it at the right place. I had that firmly impressed on me the other day. We have a freight locomotive run from Crestline to Chicago, some 240 miles and the enginehouse foreman at Fifty-fifth street, called me one morning and said, "We have a mountain type engine that came through from Crestline without grease cellars." I asked him about the condition of the journals and they were in good shape. The failure to replace the cellars happened betwen two tricks. There was plenty in the grease grooves and around the hubs to bring that engine through. My own impression is that through-run engines run largely on the first supply of grease given through the compression cut, that you do not get grease out of the cup until you get a hot pin and then you don't have any grease left. Insofar as the lubricators are concerned the auxiliary filling device or the force feed lubricator is a satisfactory answer to that question.

Some of us may have a mistaken idea that because you establish one long engine run you are going to save money. That is not true. There is only one thing that counts and that is the monthly production, either in mileage or in gross ton miles hauled. If you do not reduce the amount ot power, if you do not increase the gross ton miles per locomotive per month there is nothing in the long engine run.

The mileage that you can make with any engine service is largely dependent on the suitability of schedules. You can't always govern the length of time at your turn around point either. At some points we cut it down to perhaps four or five hours. It is perfectly safe and practical. I am firmly of the opinion that the long run improves the condition of the engine. Engine condition is seriously affected by the number of times the fire is drawn and the steam pressure reduced. There is no reason except for wear of parts why you should not run an engine indefinitely. The modern locomotive is reasonably well designed to run at least one thousand miles.

Mr. Hamilton: The first thing to do is to get the greatest possible locomotive mileage without going into heavy capital expenditure. After that consider the heavy capital expenditures and what further is justified. *The report was accepted.*

Nineteen Twenty Seven Officers Hold Over

In view of the agreement that the officers of the division serve for two years the formal balloting was not held. The officers, as named in the report of the nominating committee, which appears elsewhere in the proceedings, were therefore elected on a ballot cast by the secretary.

The convention adjourned.

A Great Northern Train of 98 Loaded and 4 Empty Cars on a 1.8 Per Cent Grade on the West Slope of the Rocky Mountains at Black Tail, Mont. This Train Covered a Distance of 127 Miles in 12 Hours, 55 Minutes, Running Time

Looking Backward

Fifty Years Ago

The Philadelphia & Atlantic City, a narrow-gage line, [now part of the Reading] between Camden, N. J., and Atlantic City, 55 miles, is near enough to completion that the operation of the first train can be announced for early in July. The road is intended mainly for pleasure travel to and from the sea-coast.—*Railway Age,* June 14, 1877.

Because of a continuation of the depression in all business interests which has adversely affected the usual revenues of railway companies the Pennsylvania has notified its employees that all who are now receiving more than 10 cents per hour will be subject to a 10 per cent reduction in wages. The Brotherhood of Locomotive Engineers has announced its acceptance of the reduction.—*Railroad Gazette,* June 8, 1877.

Twenty-Five Years Ago

The Indiana Harbor [now the Indiana Harbor Belt] is building an industrial railroad to connect Indiana Harbor, Ind., with a number of through lines entering Chicago. Grading is completed from Indiana Harbor to East Chicago.—*Railway Age,* June 13, 1902.

During the season just closed the Southern Pacific and the Santa Fe brought 22,000 persons from the east on one-way colonist tickets. It is estimated that 14,000 of the number have made arrangements to remain in California permanently.—*Railway and Engineering Review,* June 14, 1902.

The New York Central and the Pennsylvania have announced that on June 15 they will inaugurate 20-hour trains between New York and Chicago, to be known as the "Twentieth Century Limited" and the "Pennsylvania Special" respectively. A 20-hour train was operated all through the summer of 1893 by the New York Central and the Lake Shore under the name of the "Exposition Flyer."—*Railroad Gazette,* June 13, 1902.

New York newspapers state that the Pennsylvania has posted the following order at the wickets in the Jersey City station: "All trainmen, gatemen and ticket examiners in charge of the exits will stop all persons from exchanging kisses upon the arrival and departure of trains." The order is intended to prevent kissers from interfering with other persons passing to or from trains.—*Railway and Engineering Review,* June 14, 1902.

Ten Years Ago

The American Railway Association's latest bulletin on car shortage statistics shows that the net shortage on May 1 was 145,449 cars. This is the largest figure reported since the present shortage began in September, 1916.—*Railway Review,* June 9, 1917.

Contrary to the view of other shippers that had appeared before the Interstate Commerce Commission hearing in the freight rate advance, John M. Glenn, secretary of the Illinois Manufacturers' Association, declared in his testimony on June 1 that the present emergency demanded an advance in freight rates. "We know that we must have cars and the necessary facilities or chaos will reign," said Mr. Glenn.—*Railway Review,* June 9, 1917.

In spite of the injunction granted last week in the Illinois Superior court restraining the railroads operating in that state from raising their passenger fares above the statutory rate of two cents, the Wabash raised its fare from 2 cents to 2.4 cents per mile on May 31. The railroads face the alternative of raising fares to 2.4 cents and becoming subject to citation for contempt in the Superior court or of continuing at the 2 cent rate and being cited for contempt in the District court.—*Railway Age,* June 8, 1917.

New Books

Books and Pamphlets of Special Interest to Railroaders

(Compiled by Elizabeth Cullen, Reference Librarian, Bureau of Railway Economics, Washington, D. C.)

Books and Pamphlets

California and the Nation 1850-1869.—A study of the Relations of a Frontier Community with the Federal Government, by Joseph Ellison. Chapter VIII, "Means of communication and transportation," discusses mail facilities, wagon roads, and the early Pacific railroad projects together with the social and economic factors affecting them. Footnotes and bibliography list many valuable and interesting original sources. 258 p. Pub. by University of California Press, Berkeley, Cal., $3.50.

Electrical Industry. Documentation prepared for International Economic Conference, Geneva, May, 1927, and containing on page 41, a table showing electrification of railways (standard gauge) with some comment on the statistical difficulties encountered, a survey of electrical power in transport on pages 90-91, note on electrification of Italian railways on pages 113-117, and statistics of electrification of French railways, Jan. 1, 1927, on pages 120-121. 121 p. Pub. by League of Nations, Economic and Financial Section, Geneva, Switzerland.

Safety Codes for the Prevention of Dust Explosions. Sponsored by National Fire Protection Association and U. S. Dept. of Agriculture and published as Bulletin No. 433 of the Bureau of Labor Statistics. Code for prevention of dust explosions in terminal grain elevators, p. 12-16; for installation of pulverized-fuel systems, p. 25-36. 40 p. Pub. by Government Printing Office, Washington, D. C. 10 cents.

Periodical Articles

Air Services at Copenhagen Increased, by Ellis A. Johnson. "These rates [air-service between Copenhagen and 14 European cities] are practically equivalent to the second-class railroad fare for such journeys." Commerce Reports, June 6, 1927, p. 595.

The Lubrication of Waste-Packed Bearings, by G. B. Karelitz. Mechanical Engineering, June, 1927, p. 663-670.

To Every Man His Dream—But to Hugh Newson Two Dreams, by Mildred Harrington. An illustrated article about the glorified toy railway system and the Junior Railway Club whose members operate it, both of which were started by a musician who likes railways. American Magazine, June, 1927, p. 68-71, 209-214.

"Use Tact When You Can—Fight When You Must." 10th installment of biography of Gustavus F. Swift by Louis F. Swift in collaboration with Arthur Van Vlissingen, Jr., containing an account of the inception of refrigerator car service for meats, and some incidents of the Pullman strike and other strikes. Illustrations from old prints of early refrigerator cars and pictures of stockyards, etc. System, June, 1927, p. 769-771, 801-805.

Beaconsfield, Mass., on the B. & A.

Odds and Ends of Railroading

It is pleasure to observe that the idea of using musical chimes for calling hungry passengers to the diner is spreading. This practice is now being followed on the Golden State Limited of the Rock Island Lines, as well as on other lines previously mentioned.

While on the subject of railway music, Earl C. Mikesell, engine wiper at the Chicago & Alton roundhouse at Bloomington, Ill., should be mentioned. Earl is the composer of a popular song that is now being broadcast through many radio stations and is having quite a vogue elsewhere.

F. G. Ruthrauff, district freight and passenger agent of the Southern Pacific at Ogden, Utah, has received a rather unusual honor, for a railway man, in being appointed president of the Utah Art Institute by Governor George H. Dern. Railroading and painting have been Mr. Ruthrauff's lifetime hobbies and he has achieved considerable success at both. He spent a year in 1923 studying art in Paris and has had several of his pictures on display at various art institutes here and abroad.

An old feud, so old in fact that no one knows now what it was all about, came to an end May 20, when the Pioneer Limited of the Chicago, Milwaukee & St. Paul left Chicago equipped with Pullman cars. For 37 years, the C. M. & St. P. has been operating its own sleepers, ever since Roswell Miller, then president of the railroad, had an argument with George M. Pullman. The C. M. & St. P. is the only large railroad in the United States which has not been operating Pullman cars.

One crew of section men on the Rock Island in the vicinity of Brinkley, Ark., encountered more or less of a menagerie while they were sandbagging tracks during the flood. They found, among other things, a whole colony of water moccasins cuddled between the ties, and they also killed a green sea turtle weighing over 100 lbs., which they found wedged between the rails when the water went down. This is the same division where a dog is said to have rescued a rabbit from the flood, but there is no record of any one having seen any green elephants or pink crocodiles.

Charles R. Langan, who acted as conductor on the first Pioneer Limited, a five-car train, on the Chicago, Milwaukee & St. Paul, between St. Paul and Chicago, nearly 30 years ago, was in charge of the New Pioneer Limited, a 14-car train, when it left the Union station at St. Paul on May 21. Mr. Langan has 48 years as passenger conductor to his credit, receiving this promotion in the days when the men passengers shortened the time on a run by helping the crew load wood for fuel. Among other trains Mr. Langan has been a conductor on special trains for President McKinley, President Taft and J. P. Morgan.

Every now and then the newspapers record the passing of a railroad hero of other days, who rose to fame by some startling feat when railroading was new and raw and then passed again into oblivion. The latest of these is Thomas Sullivan, 67, Northern Pacific trainman, who died in St. Paul recently. Mr. Sullivan was one of the crew that saved more than 300 persons during the forest fire that destroyed Hinckley, Minn., in 1894. At great risk to his own life, he helped man a train through the blazing forest from Duluth to Hinckley and removed the refugees, after suffering severe burns himself.

Now that Porter Allen has returned to the Western region of the Pennsylvania as chief engineer of maintenance-of-way Pennsy employees at the Union Station, Chicago, are proudly retelling the story of train order No. 1028 to prove the streak of human sympathy which a "heartless" corporation and its officers may exhibit when necessary. The order, issued by Mr. Allen when superintendent of the South Bend division in 1923, was widely copied and commented upon by newspapers and provided the urge for at least one bit of verse: "To all Trains South:—On account of serious illness of young boy residing at Bowers station, near our tracks, trains while passing through will make as little noise as possible.—P. A."

The wool and mutton raising business, losing its pioneer flavor through the inroads of improved highways and heavy automobile traffic, has gained modern methods with the help of the railroad. Sheepmen no longer find it possible to trail the ewes with lambs by their sides hundreds of miles from winter quarters in Washington and Oregon along the Columbia river to summer feeding ranges in northern Washington and central Montana because of the number of vehicles on the highways. Up to June 1 the Spokane, Portland & Seattle had moved this season more than 180 cars of sheep on a "feeding in transit" rate. J. T. Hardy, general agent for the S. P. & S. at Spokane, estimates that the movement may involve 70,000 head.

Passengers who travelled from Chicago to the Pacific coast on the Oriental Limited on May 9-12 must thank Ralph Budd, president of the Great Northern, for their escape from a lengthy delay at a wayside station not far from the North Dakota-Montana state line. With nearly two hours time already lost, a broken valve on the locomotive forced a stop at Brockton, Mont. Word was sent for a relief engine and as the passengers settled down for a tedious rest a train of business cars stopped at the town. A hasty conference resulted in coupling the locomotive of the president's train to the fast passenger. While the Oriental limited steamed westward, later arriving at Seattle on time, Mr. Budd and his staff of officials made an inspection at an unscheduled point as they waited for the relief engine.

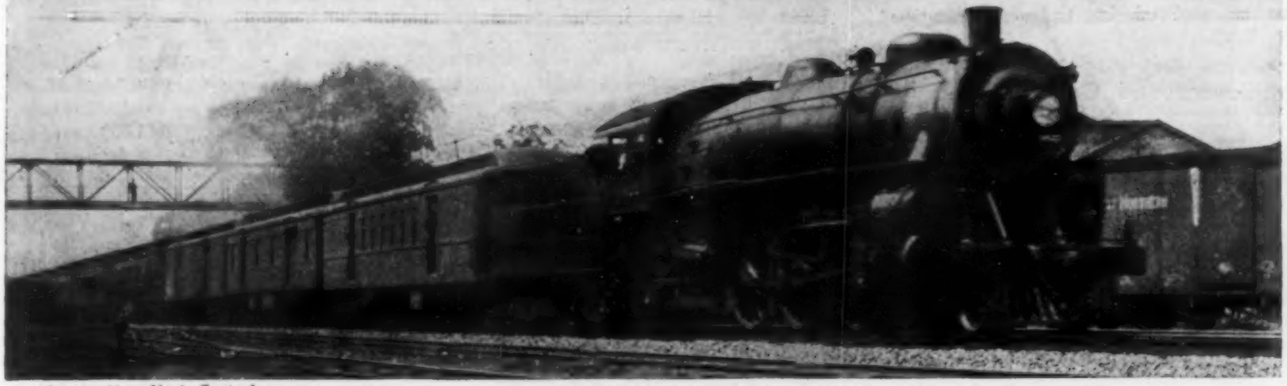
"There is surely no lack of men among us," writes H. L. Mencken in the American Mercury for June, "who would make intelligent, conscientious and even brilliant Presidents. I heave a brick at random, and after hitting Glenn Frank, Litt. D., president of the University of Wisconsin, it bounces from him to kiss Daniel Willard, LL.D., president of the Baltimore & Ohio Railroad . . . . ." He then proceeds to mention four other men who are outstandingly successful in various callings. We have not heard of any railroad executive ever seeking such honors—however, it is not a half bad idea at that. Any man who has the skill to run successfully a large railroad with all its problems—financial and technical—the while maintaining cordial public and employee relationships ought to find that his apprenticeship for the chief executive post in the land had been more than usually thorough.

Just north of Scott City, Kan., a locomotive stands on several rail lengths of track as a memorial to the intensive persecution of the Scott City Northern by an impatient creditor. After a feverish career from the time of its chartering in 1911, which included its sale from receivership in 1913 and the reduction of its motive power from three locomotives to one, it was again placed in the hands of a receiver in 1917. When the purchaser of the property, then the Colorado, Kansas & Oklahoma, began to take up the 50 miles of rail between Scott City and Winona he found a writ of attachment against the locomotive. Leaving the rails on which the locomotive stood the remainder of track was scrapped. The creditor, with no means of removing the locomotive, let it stand as a memorial to spite. His attachment had netted nothing lucrative to satisfy his claim and the purchaser, unable to move the locomotive, contented himself with scrapping the ten passenger and two freight cars.

The Frenchmen of the East

One of the most peculiar shipments recorded recently consisted of 20,000 bull frogs which were shipped from Louisville, Ky., to the Pacific Coast, en route to Yokohama, where they will stock a bullfrog farm. The frogs were shipped in 200 specially designed water-tight cases. Apparently the people of Japan have acquired a taste for frogs' legs.

NEWS *of the* WEEK



On the New York Central

THE ANNUAL OUTING of the New York Railroad Club will be held at Travers Island, N. Y., on Thursday, June 30.

CLARENCE ROBERTS, assistant road foreman of engines of the Pennsylvania, has been appointed a member of the Executive Committee of the International Railway Fuel Association, succeeding E. E. Chapman, of the Santa Fe, who has resigned. Mr. Chapman has been appointed a member of the Advisory Committee.

THE PUBLIC SERVICE COMMISSION OF NEW YORK on May 27, added 12 crossings to its extensive program of work to be done in the elimination of highway grade crossings in the present year. These 12 are on the Delaware & Hudson, the New York Central, the Erie, the Pennsylvania, the Delaware, Lackawanna & Western, and the Norwood & St. Lawrence.

THE PUBLIC SERVICE COMMISSION of Oregon has filed another complaint with the Interstate Commerce Commission asking it to require some one or more of the railroads serving the state to extend and construct a line of railroad between Crane or Harriman, Ore., on the east, and Crescent Lake, or some adjacent point on the line of the Southern Pacific on the west, and also to require the establishment of through routes and joint rates and reasonable divisions of such rates via the new lines. The complaint states that the railroads have violated the interstate commerce act in failing to provide a large area in central Oregon with adequate and reasonable facilities.

Central of Georgia Veterans

Seven hundred men and women who have been in the employ of the Central of Georgia for 25 years or longer, have received gold emblems in honor of their long and faithful service. Some of these veterans have served 64 years and altogether their total service amounts to 25,000 years. The total number of employees of the road at the present time is about 11,000 so that the 700 represent about six per cent of the total forces. President J. J. Pelley, reviewing the situation, calls attention to the probability that 15 per cent of the employees now in the service, or 1,650, will probably still be working for the Central of Georgia in the year 1952.

1928 Mechanical Division Convention

The General Committee of the Mechanical Division of the American Railway Association and the executive committee of the Railway Supply Manufacturers' Association had an opportunity of holding a joint conference at Montreal this week. As a result, it was decided to hold the 1928 convention at Atlantic City, N. J., in connection with an exhibit by the Railway Supply Manufacturers' Association, June 13 to 20, inclusive. A delegation from Atlantic City assured the committees that the new Convention Hall would be completed in time to house both the exhibits and the convention.

Change in Rule for Settlements for Rebuilt Cars Proposed

The Interstate Commerce Commission on June 4 made public a proposed report by the director of its Bureau of Service, William P. Bartel, recommending a finding by the commission that interchange rule No. 112 of the American Railway Association is unreasonable in so far as it affects settlements to be made between railroads for rebuilt freight cars when badly damaged or destroyed. The report was made in No. 17,849, Bangor & Aroostook v. American Railway Association et al.

"The commission should find," Director Bartel recommends, "that as to past and future a rebuilt freight car is one which the carrier was or is required by the accounting rules of the commission to record in equipment investment account. The commission should find that for freight cars rebuilt in the future, the proposed rule formulated by the special committee on rebuilt cars, which contemplates settlement for cars of classes 'A' and 'D' on basis of 80 per cent of reproduction cost new, less depreciation from date rebuilt, will be reasonable. As to freight cars reconstructed in the past, the commission should find that the present rule is unreasonable and that for the future a rule which provides for settlement for cars in classes 'A' to 'D' on basis of 80 per cent of reproduction cost new, less depreciation from date rebuilt, and cars of classes 'E-1' and 'E-2' on basis of 70 per cent of reproduction cost new less depreciation from date rebuilt, will be reasonable."

Under the present rule the settlement price is based on present value, commonly referred to as the present cost of reproduction new less depreciation, computing depreciation from date of original construction.

Freight Claim Division Meets June 14

The afternoon of the first day and the morning of the second day at the annual meeting of the Freight Claim Division of the American Railway Association at Quebec, Que., on June 14 to 17, will be devoted to a study of the recent tendency toward increases in the loss and damage accounts. Addresses will be made by David Crombie (C. N. R.), W. J. King (Canada Steamship Lines), and W. H. Gatchell (Southern). The Chicago Claims Conference is arranging for a special train over the Grand Trunk from Chicago to Quebec, leaving June 12.

Among the subjects to be considered, "The Value of the O. S. & D. in Prevention Work" will be presented by F. B. Hunt (A. T. & S. F.), "Loss of Entire Packages," by E. S. Hartman (L. V.), "Concealed Damage," by W. J. Edwards (Trunk Line Inspection Bureau) and Edward Dahill, chief engineer of the Freight Container Bureau; "The Value of Publicity," by William E. Hall (A. R. A.), "The Prevention and Publicity Work of the American Railway Express Company," by J. H. Butler; "Fresh Fruits and Vegetables," by R. A. Podlech (A. T. & S. F.), and "Studies in Automobile and Sheet Steel Loadings," by C. H. Allen (G. T. R.).

"Unlocated Damage Due to Rough Handling" will be discussed by George James (C. C. C. & St. L.), C. W. Watts (M.-K.-T.), and O. Maxey (C. R. I. & P.). A. A. Sims (S. P.) will describe the activities of the southwestern lines in controlling carload damage, while J. Reichert

(C. Ga.) will describe those of the southeastern lines. "Loading Methods for Carload Consignments" will be discussed by C. W. Crawford (A. R. A.), "Studies in the Prevention of Carload Damage" will be outlined by C. L. Jellinghaus (N. Y. C.).

Employees and Compensation in March

The number of employees reported to the Interstate Commerce Commission by Class I railways for the month of March was 1,730,661, an increase of 10,141, or 0.6 per cent, over the number reported for February. The number of employees in the maintenance of way group shows an increase of 18,108. The total compensation for the month, $249,655,580, shows an increase of $21,484,010, or 9.4 per cent, but there were 27 working days in March, while February had only 23. Compared with the returns for the corresponding month last year, the number of employees in March shows a decrease of 0.9 per cent and the total compensation an increase of 0.01 per cent.

Railway Magazine Editors

The American Railway Magazine Editors' Association held its fifth annual convention at Hotel Roosevelt, New York City, on Wednesday and Thursday, June 1 and 2. The officers elected for the ensuing year are W. E. Babb of the Rock Island Magazine, president; Holcombe Parks of the Norfolk & Western Magazine, first vice-president; Miller Huggins, Frisco Magazine, second vice-president; Lucile Fishburn of the Rock Island Magazine, Chicago, secretary-treasurer.

Following the first business session, the members of the association were guests of the Long Island Railroad, being taken by special train to Long Beach. They were entertained at luncheon by George LeBoutillier, vice-president of the road. At the dinner, at the Roosevelt, on Thursday evening, the principal speakers were Lewis Wiley, business manager of the New York Times; Bruce W. Currie, editor of the Ladies' Home Journal; Samuel L. Rothafel, better known as "Roxy," and Bruce Barton.

A "Safety First" Appeal to Women

Frank H. Alfred, president of the Pere Marquette Railway, in No. 41 of his series of addresses to the public, discussing the highway crossing problem "appeals more particularly to the womanhood of the United States and Canada, inasmuch as the various appeals that have been made to the men in the past respecting traffic on the highways have seemingly not been heeded.' Perhaps, says Mr. Alfred, the mothers and wives, through their club and circles and by precept and example, may effect a reduction in the number of casualties on the highways. While the railroads are primarily interested in lowering the useless toll at the grade crossing, there is a certain relationship due to indifference and recklessness between the two types of accidents. Continuing, the circular says:

"There were 621,000 casualties on American highways for the year 1926. There were 9,483 casualties at grade crossings in the United States for the same interval. That means that there were 65 times the number of casualties on the ordinary highway that there were at the railroad crossings. . . . It is difficult to understand why 9,483 casualties at railroad crossings seem to create more concern than 621,000 casualties on the highways. Perhaps, if the mothers and wives were to start a concerted campaign of preaching safety first in the home to their husbands, sons and daughters who drive cars, they would not only reduce the number of accidents at grade crossings but also on the highway. Is this not a worthy theme for discussion in the home or in the club or circle?"

How Manufacturer Can Aid in Car Efficiency

"An opportunity for car-builders in replacements" is featured in a letter to Railway Business Association members, written by Alba B. Johnson, president of the association, commenting on the American Railway Association Car Service report enumerating the conditions requisite for greater car efficiency:

"A report of its Car Service Division approved May 26 by the American Railway Association gives prominence to the opportunity for car builders and developers of car parts and appliances to promote replacement of old cars with new by transferring emphasis from quantity of cars needed to quality—to the economies attainable through improvement in efficiency of cars.

"To do more work with a given number of cars owned, various factors, the A. R. A. reminds us, are required. A goal of 20 per cent is set for reduction of demurrage through careful supervision by industries over loading and unloading. Further possibilities are held out of increase in the load per car through study and effort by railway management and by shippers in the Regional Advisory Boards. One more mile a day per car is called for to be added to present average performance. The roads are urged to continue maintaining equipment at the highest practicable point.

"All these measures, however, are ranked secondary to another which heads the list: 'A continuation of the replacement of the smaller-capacity and less efficient cars with cars of modern type.'

"In a largely attended meeting the approval of the report by the executive was unanimous.

"From the report it appears that since January 1, 1923, the modern high-capacity cars, either new or rebuilt, placed in service were 602,507; low-capacity inefficient cars retired, 545,338.

"The report suggests that pursuing the methods enumerated it is possible to handle the traffic of the country for some time to come with a total decrease in the ownership of open top and box cars of at least 100,000. The R. B. A. has always insisted that waste benefits nobody and that the more the roads could get out of a car the faster the country would grow and, as a permanent tendency, the larger would be the car additions and replacements."

Alternative Routes for Hudson Bay Rail Port

The line to Fort Churchill, on Hudson Bay, from the present end of steel on the Hudson Bay Railway would be 154 miles long and would cost $7,543,000, as compared with 67 miles to Nelson costing $2,458,000, according to the report of the engineering branch of the Department of Railways and Canals at Ottawa, which branch was at work from January 9 to April 4 last on the survey of a possible line to Churchill. The engineers find that it would be no more difficult to build the line to Churchill than has been experienced on other parts of the Hudson Bay Railway. It remains for the government to decide and announce at the next session of Parliament which terminus will be chosen, Churchill or Nelson. It is known that the Minister of Railways and Canals is in favor of the latter.

The extra distance involved in the possible extension to Fort Churchill would entail additional interest charges and increased cost of maintenance and operation estimated in the report at $413,900 per annum on a movement of ten million bushels of grain and a reasonable general commodity traffic in both directions.

For each additional million bushels of grain, the added overhead would be about $5,655 per year, the report estimates.

With the report of the engineers Mr. Dunning received photographic views, a gratifying feature of which, he states, "is the indication of timber of good size in the vicinity of rivers and creeks."

A department statement respecting the report says:

"Unfortunately, much of the country has recently been burnt over between the Hudson Bay Railway and a point just north of Owl River, 55 miles. Though the country traversed is largely muskeg, there is abundant and definite drainage. On most of the rivers, high-water marks, where ice has jammed and cut the trees on the banks, are very noticeable. In some instances, these marks are about 20 feet above normal level. The engineers state that this feature is not so marked on the Churchill river, which indicates that the ice clears more freely on that river.

"The information secured by this survey will be most useful when, during the course of the summer, the government is in possession of the report of Frederick Palmer, the British harbor expert, who has been engaged to investigate the relative merits of Nelson and Churchill as the bay terminus of the railway."

A cablegram has been received at Ottawa from Frederick Palmer, engineer of London, Eng., engaged to study the question of a terminus and also the problem of ocean connections with the railway, that he would with his assistant, E. J. Buckton, arrive in New York on July 26 and the following evening they would join the official party which leaves here to go over the Hudson Bay Railway route to Hudson Bay, travelling by canoe from the end of steel to Nelson.

Traffic

The Hotel Saskatchewan, built by the Canadian Pacific at Regina, Sask., was formally opened on May 24, with Earl W. Beatty, president of the railroad, as the chief speaker at a banquet, celebrating the event.

The fourth annual meeting of the Northwest Shippers' Advisory Board will be held at Missoula, Mont., on June 16. Besides the reports of commodity committees and the election of officers, consideration will be given to car requirements for the movement of Montana crops. It is expected that transportation requirements will reach a maximum this year.

The Long Island Railroad announces that, beginning June 24, the company will put on a new all-Pullman train to be known as the Montauk Special, to run between New York and Montauk on Fridays and Mondays, and that this train will have a parlor car between Montauk and Washington over the Pennsylvania Railroad. The Hampton express of the Long Island now has a sleeping car, running to and from Pittsburgh, Pa., over the Pennsylvania.

The "North Shore Limited" is a new train which the New York Central established Sunday, June 5, running from New York to Chicago over the New York Central and the Michigan Central in 20 hours, 50 minutes. The train leaves New York at 12:10 p. m., Eastern time. "North Shore Limited" is also now the name of eastbound train No. 40, over this route which now leaves Chicago at 9 p. m. Central time, and runs through at the same speed.

An investigation into all the circumstances and conditions surrounding the transfer of freight within St. Louis, Mo., and East St. Louis, Ill., by dray or truck for and on behalf of the railroads, and of the allowances made by the railroads for such services, has been ordered by the Interstate Commerce Commission on its own motion following the receipt of a petition filed by the St. Louis Chamber of Commerce and other commercial organizations, and also the Chicago & Alton, requesting it to institute such an investigation.

The Gulf, Mobile & Northern announces that the Jackson & Eastern will be open through to Jackson, Miss., on July 1. Freight service will begin on July 17. The Jackson & Eastern, extending from Union, Miss., on the G. M. & N., westward, about 60 miles, to Jackson (and now in operation from Union to Lena, 33 miles), will, from July 1, be operated as a branch of the G. M. & N. Beginning July 31, the company plans to run sleeping cars on night trains No. 1 and No. 2, between Jackson and Mobile, Ala., and also between Jackson, Miss., and Jackson, Tenn.

The next regular meeting of the Trans-Missouri-Kansas Shippers' Advisory Board will be held at Wichita, Kan., on June 15. The meeting will be devoted largely to an analysis of crop conditions within the territory and to the reports of commodity committees. Carl R. Gray, president of the Union Pacific, and Hon. Homer Hoch, a congressman of Kansas, will be the principal speakers. The marketing and the transportation of the winter wheat crop will be discussed from the viewpoints of the farmer, the elevator, the mill, the banker and the railroad.

Another lake cargo coal rate case before the Interstate Commerce Commission may result from a meeting of coal operators of the southern districts held recently at Washington at which resolutions were adopted to endeavor to seek reductions in the freight rates on lake cargo coal from those districts to correspond with the 20-cent reduction per ton ordered by the commission, effective August 10, in the rates from Pennsylvania and Ohio districts. A petition urging the railroads serving southern district to make such a reduction was later placed before W. J. Harahan, president of the Chesapeake & Ohio, and A. C. Needles, president of the Norfolk & Western, who promised to give it consideration.

The Chicago, Rock Island & Pacific has applied to the Illinois Commerce Commission for permission to increase its suburban fares five per cent so that they will be on a parity with those of other railroads operating to and from Chicago. In May, 1925, seventeen roads operating suburban service out of Chicago applied to the Illinois Commerce Commission for permission to increase their suburban fares. The Chicago & North Western asked the Interstate Commerce Commission for permission to increase its fare 20 per cent and was given authority in June. In July, the Illinois Commerce Commission allowed the other roads to increase fares 15 per cent. The Atchison, Topeka & Santa Fe and the Chicago & Alton have petitioned for a five per cent increase in fares between Chicago and Joliet and intermediate points.

Passenger Service Discontinued on Georgetown Loop

The Colorado & Southern has been granted permission by the Public Utilities Commission of Colorado to discontinue for a test period of one year all passenger, baggage and express business on its Clear Creek district or Georgetown loop line, which runs from Denver, Colo., to Silver Plume. The order in no way affects the freight service of the line. The application was filed with the commission on August 10, 1926. The petition of the company shows that from 1921 to 1925, inclusive, the road had been operating at an average annual loss of $125,000. The passenger trains alone showed a loss of $22,649 in 1925. The decline of mining in the Clear Creek district and the fact that the public highways paralleling the rail lines have been so improved that the large majority of passenger travel by bus and privately owned automobile were given as reasons for the loss in business.

The railroad will be required to file rates for passenger service for groups of not less than 125 persons to any point on the line. It will also be required to carry one passenger coach with each freight train.

The "Century's" 25th Birthday

The 25th anniversary of the Twentieth Century Limited—twenty-hour train of the New York Central between New York and Chicago—occurs on June 15 and, to celebrate the event, the railroad company has issued a handsome pamphlet, lettered in silver, containing six full-page colored reproductions of the six notable paintings which have been used on the calendars of the road for the past six years, showing this train in different situations.

In 1902, the "Century" was made up of three sleeping cars, a smoking car and a dining car, and on the first trip, westbound, the number of passengers was only 27. At the present time, an average of three trains of ten cars each is run each way daily, and the annual gross earnings of the train are about $10,000,000. The cost of the first train of five cars and one locomotive was about $115,000; and 21 cars and seven locomotives, then in service, cost about $525,000. In service on these trains today are 87 sleeping cars, 15 observation cars, 12 club cars, eight dining cars and 24 locomotives—representing a gross cost of $8,000,000.

Supreme Court Reinstates Commission's Cottonseed Tariff Order

The Supreme Court of the United States has reversed the decree of the federal district court for eastern Arkansas, setting aside and enjoining enforcement of an order of the Arkansas Railroad Commission suspending for examination an intrastate commodity tariff, framed on the mileage basis, which had been filed by the Rock Island to cover cottonseed and its products.

The railroad's contention was that the Interstate Commerce Commission had found that the existing intrastate class and commodity tariff discriminated unjustly against interstate commerce; that it had ordered the removal of the discrimination; and that the railroad had therefore the right and the duty to substitute a new non-discriminating tariff. The state commission denied that the federal commission had made such finding or order. This question involved the orders in Memphis-Southwestern Investigation of Commodity Rates, 77 I. C. C., 473, and Oklahoma Commission v. Abilene & Southern, 98 I. C. C. 183.

The Supreme Court holds that the federal Commission's intention to inter-

fere with the state function of regulating intrastate rates is not to be presumed. "If, as the railroad believed, the federal commission intended to include the intrastate Arkansas rates within its order, the road should have taken action, through appropriate application, to remove the doubt by securing an expression by that commission of the intention so to do."—Arkansas Railroad Commission v. Rock Island. Decided May 31, 1927. Opinion by Mr. Justice Brandeis.

S. P. Day Coach Service Attracts Traffic

That the decline in day coach passenger traffic may be checked through faster time, improved service and better cars, is indicated by the experience of the Southern Pacific in the operation of the Daylight Limited and the San Joaquin Flyer between San Francisco, Cal., and Los Angeles, 471 miles. The Daylight Limited, a solid coach train, was placed in service in 1922, running at the same speed as that maintained by the company's fastest trains, solely for summer tourists. This train not only attracted the anticipated tourist traffic, but also other patrons preferring to travel by day rather than by night. In its first year the Daylight Limited operated twice weekly, then four times a week, and finally on a daily all-year schedule. The equipment includes a dining car, an all-day lunch car, a standard club car and a parlor observation car. All classes of tickets are accepted and no extra charge is made for the use of the club and observation cars. No local passengers are taken and the train makes but two stops between the two cities, these being for operating purposes. The train traverses the 471 miles in 12 hours.

The San Joaquin Flyer was placed in service on March 20, 1927, with results quite as satisfactory. It runs on a slightly slower schedule and handles considerable local business between points in the San Joaquin Valley in addition to through business. The equipment of this daily train includes an observation car, an all-day lunch car, a dining car and parlor cars.

A third coach train running weekly on approximately the same schedule as the Shasta Limited and designed to compete with the motor bus transportation lines was placed in service last February between Portland, Ore., and San Francisco. This service recently was increased to two trains weekly. When the Cascade was placed in service last April the coach train's running time was further shortened, and it is now but one hour slower than the 23 hr. and 20 min. schedule of the Cascade. The equipment of the coach train includes dining cars, all-day lunch cars and an observation car.

These coach trains were advertised in advance, by the use of newspaper and magazine space, and also billboard space, posters and miscellaneous printed matter. The passenger coaches recently ordered by the Southern Pacific include revolving seats with an individual chair for each passenger. In addition, transoms have been eliminated in order to permit larger windows.

Foreign Railways

Two British Locomotives for Baltimore & Ohio Pageant

The Great Western Railway, it is announced in Modern Transport (London), will send its historical locomotive the "North Star" to Baltimore to be operated in the Baltimore & Ohio's centennial pageant this fall. Moreover, the same company has agreed to build "as fine a type of British locomotive as can possibly be developed" which also will be sent to the Baltimore celebration.

Railway Mileage of Latvia

Consul John Farr Simons, Riga, Latvia, reports in Commerce Reports that a review of the Latvian railways for the fiscal year ended March 31, 1927, indicates that there were 1,815 miles of line. The State Railways had 930 miles of Russian gage, 290 miles of standard gage and 500 miles of narrow gage; while of the privately owned lines, one is of 30 miles (narrow-gage), connecting the port of Libau with the town of Aixpute, and the other is of 70 miles (narrow-gage) connecting the small port of Ainazi with the town of Smiltena. Construction work on the new broad-gage line of 100 miles, between Libau and Gluda is progressing satisfactorily. This line, when completed, will form a new and important link between inland Russia and the Baltic sea and will do much to utilize the port facilities of Libau, which are now little used, owing to the closing of freight traffic across Lithuania on the Romney-Minsk-Vilna-Libau line.

New Tilbury-Dunkirk Route

The London Midland & Scottish Railway, the Anglettere-Lorraine-Alsace Société Anonyme de Navigation, which latter owns and operates the cross-Channel steamers, and the Northern Railway of France, have opened the new route between England and the Continent via Tilbury and Dunkirk. There are daily sailings (including Sundays) in both directions, and through connections without change are being provided from the principal centers of population in Scotland, the North of England, and the Midlands to Tilbury. While the fare compares favorably with other routes, the new route will effect a saving in time for business travelers between the North of England and Paris and the Continent generally. Thus, the North of England business man having completed his day's work will be able to get a through train to Tilbury, have dinner on the train, take the boat, have a night's sleep on board, and be in Paris the next day for business. For example, the connecting trains leave Leeds at 5:15 p.m. and Manchester at 5:50 p.m.

On the return journey, Manchester is reached at 12:53 p.m. and Leeds at 1:45 p.m. Dining cars are being run on all the boat trains between Tilbury and St. Pancras (London), and between Dunkirk and Paris. In addition to Paris, the new service provides through connections with many other Continental towns. As well as passenger traffic, it is hoped that the new service will soon handle a large freight traffic, as the vessels employed are especially suited to the demands of the Continental trade, and their construction permits of rapid loading and unloading, with good clearance into and out of the holds.

Czechoslovak Railways Place Large Equipment Order

The Czechoslovak Railway Ministry recently signed orders for 33 locomotives valued at 32,200,000 Czechoslovak crowns,* all of which will be built locally, Commercial Attaché Elbert Baldwin, Prague, reports to the Department of Commerce.

Orders were also placed at the same time for 120 standard-gage third class passenger cars to cost 198,000 Czechoslovak crowns, each, 2 narrow-gage second and third class cars to cost 127,000 Czechoslovak crowns each, and 3 narrow-gage third class cars to cost 127,000 Czechoslovak crowns each. The total value of car orders is 25,400,000 Czechoslovak crowns.

Further orders were placed for 30 railway mail cars valued at 8,900,000 Czechoslovak crowns, and divided in three categories to cost 191,000, 225,600 and 472,000 each.

Orders for four motor-driven cars were also placed. These motor-driven cars will burn Dynalkol, a compound fuel recently developed in Czechoslovakia and composed of alcohol, benzol and kerosene, instead of gasoline. These cars will be placed in operation during this summer.

*The Czechoslovak crown is equivalent to approximately 3 cents.

Russian Railway Notes

The Railways of the Russian Soviet Union are planning the erection of a large car plant, to have an annual capacity of 5,000 cars of American type, at New Taghil, according to a report issued by the American-Russian Chamber of Commerce, New York. The plant, it is estimated, will cost $22,000,000.

Car loadings for the month of March showed an increase of 15 per cent over the average monthly loading of a year ago.

A new three-cylinder locomotive, first of the type to be built in the Soviet Union, with a weight in working order of 90.5 tons, has just been completed by the Putiloff Locomotive Works. Another Diesel locomotive has been ordered from a Leningrad plant which is designed to handle 1,500 tons at a speed of 30 miles an hour. The manufacturers in that city now have a capacity of 50 such locomotives per annum.

Recent increased assignments of power

to the Trans-Caucasus line have resulted in an increase to 243 tank cars daily in the loading of petroleum in that district.

The practice of assigning each locomotive to one engineman for his exclusive use is being abandoned and the power is being pooled.

International Railway Union Meeting in Stockholm

Four of the five commissions of the International Railway Union are meeting in Stockholm, June 9-22, states a report from Consul General John Ball Osborne, Stockholm, made public by the Department of Commerce.

The commissions called to Stockholm are the Technical Commission, the Commission for Passenger Traffic, the Commission for Freight Traffic and the Commission for the exchange of Rolling Stock. The fifth commission, which handles questions pertaining to currencies and rates of exchange, is not considered to have matters of sufficient importance at present to warrant a meeting.

The Technical Commission, which is the largest, having about 40 to 45 members (the other have 20 to 25), traveled to Stockholm by way of Goteborg, inspecting various manufacturing plants en route.

New Rome-Naples Line Built

A new railway line from Rome to Naples, popularly styled "La Direttissima," has been completed. Twenty years ago this line was seriously considered, and the work was actually begun before the war. Owing, however, to financial and other difficulties, work proceeded very slowly, and was suspended for a time. The line will be opened for public service on October 28, the anniversary of the Fascist march on Rome.

The existing route via Cassino and Capua has long been inadequate for the increasing traffic. The new route reduces the distance from 155 to 135 miles, and the time from four or five hours to three and a half hours. Within a year, it is expected, the time of the journey will be shortened to less than three hours.

The new railway follows the general course of the ancient Appian Way, by which the victorious legions so often approached the Imperial City. Starting from the terminus at Rome it passes the aqueduct of Claudius and crosses the broad plain known as the Agro Romano. Then, running along the foot of the Volscian mountains, it traverses the entire length of the Pontine district, once ill-famed for its malarial marshes, but today well cultivated and productive. Next it penetrates the Ausonian mountains by a long tunnel, runs through the plain of Fondi, touches the sea at Formia, crosses the River Garigliano on a viaduct, and, after passing through another long tunnel which pierces Monte Massico, enters the low-lying valley of the Volturno. After crossing this river by another iron bridge the line debouches into the Phlegraean Fields.

The scenery is interesting to the tourist. More than one ancient Roman necropolis, ruined towers and amphitheaters were disinterred in the course of the construction of the line.

There are in all 17 stations, so placed as to secure the highest economic development of the region traversed. Till now two secondary railways, neither of them very efficient, have served part of the country covered—the Roma-Velletri-Terracina line, crossed by the new line at Sezze Romano, now linked up with the new line at Formia. By the new line of communication a fertile region is effectively opened up.

One of the most important points en route is Vico di Pantano, from which a connecting line has been constructed to Aversa; while the existing line from Aversa to Naples has been completely overhauled, double track completed, grade crossings abolished and a new station erected at Aversa. The Pozzuoli-Naples section, which lies within the province of Naples, is electrified, on the third-rail system; on the rest of the line steam traction will be employed.

Trains proceeding from Rome will be divided in two at Vico, one part going via Pozzuoli to the Chiaia station at Naples, which now becomes the chief station for the passenger traffic from Rome. The other part of the train will go via Aversa to Naples Central Station. In the same way two trains from Rome will leave the Chiaia and Central stations of Naples simultaneously, and unite on reaching Vico.

The railway is designed for heavy traffic, with a double track of standard gauge. There are long sections of straight line, including one stretch of nine miles and two of nearly seven miles each; in all about 110 miles. For 45 miles the line is on the level. The grades are easy. The greatest height above sea-level is about 413 feet. There are no grade crossings. The tunnels number 14, of a total length of fully 21 miles, including those of Montorso (Ausonian Mountains) and Vivola, about six and a half miles each, that of Mount Massico nearly three and a half miles, and the long tunnel under Naples. Forty-six bridges and viaducts are crossed en route, of spans varying from 30 to 230 feet.

Certain difficulties of a special nature have been successfully surmounted. It was no easy matter to lay secure foundations in the region of the Pontine Marshes. The swampy ground bordering the Garigliano and the Volturno presented similar difficulties. In some of the mountains excavation was difficult on account of the existence of natural caverns. In the Phlegraean region, especially near the crater of Solfatara, the chief obstacle was the high temperature of the rock, reaching sometimes 152 deg. Fahrenheit, and the presence of gaseous exhalations.

All the stations have modern equipment, and an abundant water supply. Artistic skill has been lavished on the Chiaia station at Naples, which is regarded as a monument to the entire enterprise. Its facade, in the Renaissance style, has three large arches, the central one surmounted with a large clock, while the others are adorned with the heraldic emblems of Italy and also with that of the Commune of Naples.

Equipment and Supplies

Locomotives

THE PERUVIAN GOVERNMENT has ordered two Mikado type locomotives from the Baldwin Locomotive Works.

THE JOHNSTOWN & STONY CREEK has ordered one six-wheel switching locomotive from the Baldwin Locomotive Works.

THE USINA JUNQUEIRA, Peru, has ordered through a New York representative one consolidation type locomotive from the American Locomotive Company.

THE KANSAS, OKLAHOMA & GULF has ordered one lot of three and an additional order of two, 2-10-2 type locomotives from the Baldwin Locomotive Works.

THE PEORIA & PEKIN UNION has ordered three eight-wheel switching locomotives from the Baldwin Locomotive Works. Inquiry for this equipment was reported in the *Railway Age* of May 21.

THE AMTORG TRADING CORPORATION, New York, has ordered three saddle-tank locomotives from the American Locomotive Company. This equipment is for service on a hydro-electric project on the Dnieper river near Kharkov, Russia.

THE LEHIGH & NEW ENGLAND has ordered 3 light type eight-wheel switching locomotives, 3 heavy type eight-wheel switching locomotives and 2 Decapod type locomotives from the Baldwin Locomotive Works. Inquiry for 6 switching locomotives was reported in the *Railway Age* of May 14.

Freight Cars

THE CHICAGO & ILLINOIS MIDLAND has ordered 350 coal cars from the Pullman Car & Manufacturing Corporation. Inquiry for this equipment was reported in the *Railway Age* of May 7.

THE WESTERN PACIFIC has ordered 40 air dump cars of 30 cu. yd. capacity from the Western Wheeled Scraper Company. Inquiry for this equipment was reported in the *Railway Age* of May 28.

THE UNION PACIFIC has ordered six automatic air dump cars of 20 cu. yd. capacity from the Western Wheeled Scraper Company. Inquiry for this equipment was reported in the *Railway* Age of May 7.

THE ILLINOIS CENTRAL has ordered 500 gondola cars from the American Car & Foundry Company; 500 gondola cars from the Illinois Car & Manufacturing Company; 300 hopper cars and 500 box cars from the Pullman Car & Manufacturing

Corporation; 500 automobile furniture cars from the General American Car Company; 700 hopper cars from the Standard Steel Car Company; 500 automobile furniture cars from the Pressed Steel Car Company; 500 box cars from the Mt. Vernon Car Manufacturing Company, and 500 flat cars from the Bettendorf Company. Inquiry for this equipment was reported in the *Railway Age* of May 7.

THE AMTORG TRADING CORPORATION, New York, has ordered 25 dump cars of 40 tons' and 20 cu. yd. capacity, from the Pressed Steel Car Company, to be built at its Koppel plant. This equipment is for service on a hydro-electric project on the Dnieper river near Kharkov, Russia.

THE PENNSYLVANIA has arranged for the construction of 12 flat cars of special design. They will be built with depressed centers, for the purpose of carrying shipments of great weight and large dimensions. Two of these cars will be of the type known as F28. This class of car is designed primarily for shipments of armatures, turbo-generators, transformers and large castings, and will have a carrying capacity of 275,000 lb. The bulk of the shipments will be carried in the central depressed portion, which is 25 ft. in length and 6 ft. 8 in. wide between the side sills. The length of the car body is 52 ft. 6 in. and total length of car 54 ft. 6½ in. The car will be equipped with six wheel trucks of special design and will weigh about 105,000 lb. The other ten cars, which will be classified as F29, have been specially designed for shipments of transformers. The depressed center is 20 ft. in length and 8 ft. wide. The nature of the lading to be carried will not permit side sills extending above the depression, and the weight of load to be carried has for this reason been restricted to 230,000 lb. The car itself will weigh about 100,000 lb. The length of body and total length will be the same as in the case of the F28 car. The six wheel trucks will be of the same special design used with the F28 car.

Iron and Steel

THE READING has ordered 250 tons of steel for a bridge at Atlantic City, from the Phoenix Bridge Company.

THE BALTIMORE & OHIO is inquiring for 250 tons of steel for bridges. An order for 275 tons for bridges was recently let to the Mt. Vernon Bridge Company.

THE CHICAGO, BURLINGTON & QUINCY has ordered 300 tons of structural steel for miscellaneous bridge work from the American Bridge Company and 100 tons from the Vierling Steel Works.

THE PENNSYLVANIA is inquiring for 1,000 tons of steel for substations. The company is also inquiring for 400 tons of steel for a bridge at Toledo, Ohio, and for 300 tons for bridges at different places. An order was recently placed with the American Bridge Company for 250 tons of steel.

Machinery and Tools

THE BOSTON & MAINE has ordered two, 25-ton locomotive cranes from the Brown Hoisting Machinery Company.

THE UNION PACIFIC has ordered a 90-in. locomotive axle journal turning lathe from the Niles-Bement-Pond Company.

THE CINCINNATI, HAMILTON & DAYTON has ordered a 48-in., 400-ton wheel press from the Niles-Bement-Pond Company.

THE BALDWIN LOCOMOTIVE WORKS is inquiring for a number of machine tools, 44 electric traveling cranes and 12 crane bridges for its Eddystone plant.

THE AMTORG TRADING CORPORATION, New York, has ordered three, 40-ton locomotive cranes from the Industrial Works, and two steam shovels from the Marion Steam Shovel Works. This equipment is for service on a hydro-electric project on the Dnieper river near Kharkov, Russia.

Signaling

THE NEW YORK CENTRAL has ordered from the General Railway Signal Company, an electric interlocking for West Haverstraw, N. Y., 25 working levers.

THE SOUTHERN PACIFIC has ordered from the Morkium-Kleinschmidt Corporation three printing telegraph circuits, including a two-channel Multiplex circuit to be put in service between San Francisco, Cal., and Los Angeles, a drop channel Multiplex circuit to operate between San Francisco and Houston, Tex., with a drop at El Paso, Tex., and a drop channel circuit to operate between Houston and New York, with a drop at Chicago.

EIGHTY HOURS from San Francisco, Cal., to New York City in an automobile, was the record made by Louis B. Miller of San Francisco who arrived in New York City at 8:55 p.m., Eastern time, on the evening of June 3. Mr. Miller had with him one companion, the two taking two-hour turns at driving. The time, through was three hours better than that made by Mr. Miller in August, 1926. The last stage of the journey was by special ferry boat across the Hudson River, and while on the boat (about six minutes), the tires of the automobile were changed. Miller calculates that he traveled 3,385 miles, making the average speed 42.42 miles an hour. In crossing Nevada, a distance of 365 miles was made in five hours. The trip was made to test the efficiency of a new type of headlight. Miller and his companion remained in New York less than five minutes, starting at once on the return journey, with a view to making a round-trip record.

Supply Trade

Gordon L. Edwards, assistant treasurer of the **United States Steel Corporation,** has ben elected treasurer to succeed F. M. Waterman, deceased, and **J. H. Gewecke,** assistant treasurer, has been appointed first assistant treasurer, both with headquarters at New York City.

Eric H. Ewertz, general manager of the Moore plant of the Bethlehem Steel Company, has resigned to open an office as an independent consulting engineer at 50 Church street, New York. Mr. Ewertz will deal with problems relating to welding, mechanical and economic engineering. A graduate mechanical engineer, he has had 30 years' experience in engineering fields, including the management of large manufacturing plants. Among the enterprises with which he has been connected are the Navy Yard, Sweden; Schwartzkopf Machine Company, Berlin, Germany; Victor Metals Company, Braintree, Mass.; Bethlehem Steel Company, Elizabeth, N. J., and a number of shipbuilding organizations. This experience covers construction and design of machinery and parts and structural work. Mr. Ewertz is one of the founders of the American Welding Society and a past president of that organization.

Obituary

Alexander B. Brown, representative for the entire Dominion of Canada of the air brake activities of the Canadian Westinghouse Company, Ltd., died on June 8.

Charles D. Wood, president of the R. D. Wood Company, Philadelphia, Pa., died of heart disease suddenly on June 8, in a room in the Hotel Sherman, Chicago, in the midst of a session of the executive committee of the American Waterworks Association which he was attending.

Trade Publications

TRACK CIRCUIT HAND BOOK.—This is the name of a new treatise prepared by M. W. Manz, manager railroad material sales, in collaboration with J. B. Weigel and W. P. Bovard, engineers of the Ohio Brass Company, Mansfield, O., which is of interest to officers in charge of track maintenance and signaling because of the large amount of space devoted to rail bonds. Particular attention is given to the theories and facts concerning the gas welded bonding and the application, maintenance and economy of the low resistance type of bond. Part 2 comprises an exhaustive study of the methods of making computations for a-c, and d-c, track circuits and Part 3 contains a series of tables and charts for use in circuit computations. The book contains 154 pages 7½ in. by 5 in. bound in fabricoid and is well illustrated.

Construction

Baltimore & Ohio.—This road has let a contract to the Vang Construction Company, Cumberland, Md., for the construction of a bridge at Greenfield, O., to cost approximately $60,000, and a subway at Cumberland, Md., to cost approximately $25,000.

Central of New Jersey.—This road has let a contract for necessary grading for the widening of its roadbed west of its Bethlehem engine terminal, and for the relocation of the public highway adjacent thereto, at Bethlehem, Pa., to cost about $55,350, to the firm of F. H. Clement & Co.

Chicago, Burlington & Quincy.—Plans have been prepared for the construction of a one-story brick combined passenger and freight station at Brush, Colo., to have outside dimensions of 28 ft. by 110 ft.

Chicago, Springfield & St. Louis; Jacksonvile & Havana.—Plans have been prepared for the construction of a six-stall roundhouse at Springfield, Ill., with company forces. These companies also plan the rehabilitation of the roundhouse and shops at Jacksonville, Ill.

Great Northern.—The city council of Bellingham, Wash., has granted the petition of this company for the vacation of a portion of D street in that city for the construction of a passenger station at an estimated cost of $60,000.

Long Island.—The New York State Transit Commission (New York City) has issued an order directing this company to eliminate five grade crossings at Ozone Park, N. Y., all of the crossings being within a stretch of line about one-half mile long. This is a four track line, electrically operated; estimated total cost of the proposed work, $2,136,600.

Louisville & Nashville.—The Interstate Commerce Commission has issued a certificate authorizing the construction of a new line from Chevrolet, Ky., to Hagans, Va., 13.87 miles and the operation under trackage rights of a line of the Interstate Railroad from a point near Norton to Miller Yard, Va., about 18 miles, to connect the Eastern Kentucky division of the L. & N., with the line of the Carolina, Clinchfield & Ohio, in partial compliance with a condition imposed by the commission in connection with its authorization of a lease of the C. C. & O., by the Atlantic Coast Line and the L. & N. The estimated cost is $5,287,000.

Missouri Pacific.—A contract for the construction of the walls, reinforced concrete floors and exterior terra cotta trim of the 22-story general office building at St. Louis, Mo., has been awarded to the Humes-Deal Construction Company, St. Louis.

New York Central.—This road has awarded a contract to Louis Chevalier, Inc., New York, for the construction of a substation at Hastings, N. Y. A contract also has been awarded the Chicago Pneumatic Tool Company, New York, for the manufacture, delivery and erection of a power house at Buffalo, N. Y. The company has let a contract to the Lyons-Slattery Company, Inc., New York, for the construction of a substructure and superstructure of a bridge at Dyckman Street, New York. The Walsh Construction Company, Syracuse, N. Y., has been awarded a contract for the construction of a power house at Buffalo, N. Y.

New York, New Haven & Hartford.—This road has let a contract to Henry R. Kent & Co., Rutherford, N. J., for the construction of a central boiler plant at South Boston, Mass., to cost approximately $500,000.

Northern Pacific.—This company has asked for bids for the construction of an extension from a point 2 miles west of Glendive, Mont., to Brockway, 62 miles, at an estimated cost of about $2,000,000.

Oregon-Washington Railroad & Navigation Company.—A contract for grading and widening of cuts and embankments at a number of points between Huntington, Ore., and Pendleton, to provide for the extension of passing tracks, has been let to Clifton, Applegate and Toole, Spokane, Wash., at an approximate cost of $150,000.

Pennsylvania.—This road has let a contract for the construction of an overhead bridge and viaduct to eliminate a grade crossing at Rouseville, Pa., to cost about $50,000, to the Milliron Construction Company, DuBois, Pa., and a contract for drainage and paving of driveways at the Woodland Ave. freight house, Cleveland, O., to the Dresser Company of Cleveland. The road has awarded contracts to the T. F. Foley Construction Company, Pittsburgh, Pa., for building a bridge at Wooster, O., to cost about $75,000; a bridge at New Galilee, Pa., to cost about $75,000; and an engine house extension at West Morrisville, Pa., to cost about $75,000.

St. Louis-San Francisco.—This company will divide with the city of Springfield, Mo., the cost of a highway subway at National avenue and a viaduct at Benton avenue, estimated to require total expenditures of $90,000 and $75,000 respectively.

Seaboard-All Florida.—This company, a subsidiary of the Seaboard Air Line, has applied to the Interstate Commerce Commission for a further extension of time from June 1 to November 1 for the completion of its extensions in Florida. The application, signed by L. R. Powel, Jr., vice-president of the company, states that 68.84 miles of the line, from West Palm Beach to Miami, was completed in January and that rails have been laid on the 34.59 miles from Miami to Florida City, but that further time is needed for completion of the construction.

Southern.—This road has given a contract for constructing an office building at Danville, Va., to cost $35,000, to the J. P. Pettyjohn & Co., Lynchburg, Va.

Financial

Alton & Eastern.—*Securities.*—This company has applied to the Interstate Commerce Commission for authority for the authentication and delivery of $1,000,000 of first mortgage 6 per cent bonds and $995,000 of additional stock, to be issued to the Illinois Company in payment for the railroad property acquired from it.

Atlanta, Birmingham & Coast.—*Delivery of Certificates.*—This company has given notice that the definitive engraved certificates for preferred stock have been prepared and are now ready for delivery. Holders are requested to present or send temporary certificates to the Chase National Bank, New York, Stock Transfer Department, 46 Cedar street, New York, for exchange.

Boston & Maine.—*Bonds.*—This company, through the co-operation of the United States Treasury Department and Kidder, Peabody & Co., Lee, Higginson & Co., and Harris Forbes & Co., Inc., has been able to effect an arrangement by which $26,980,000 of Boston & Maine bonds held by the Railroad Administration will become subject to call by the railroad. The securities include $25,950,000 of bonds acquired by the United States Railroad Administration under Section 7 of the Federal Control Act, and $1,030,000 of bonds acquired under Section 207 of the Transportation Act, 1920; each issue bearing interest at 6 per cent, and maturing January 1, 1929. The effect of this arrangement is to insure to the Boston & Maine the right to take up these bonds under the most favorable financing conditions which may obtain between now and the date of maturity. This transaction is the result of an offer for the bonds made recently to the United States Treasury Department by a New York banking syndicate. It was the purpose of this syndicate to re-sell the bonds to the general public which would have taken these securities out of the railroad's control. It being desirable that if these bonds were to be sold, it should be under conditions which would permit refinancing whenever market conditions make it advantageous for the railroad to do so, the management asked the Treasury Department and the Boston banking interests who had served as syndicate managers in the recent financial reorganization of this property, to co-operate with the railroad in an effort to bring the obligations within the railroad's control.

Canadian National.—*Bonds Sold.*—This company has awarded its issue of 30-year 4½ per cent bonds, unconditionally guaranteed as to principal and interest by the Dominion of Canada, to a syndicate headed by Blair & Co., the Chase Securities Corporation and the Equitable Trust Company, all of New York, and the First National Corporation of Boston. The bidding for this issue was reported to have been close, two other syndicates being lively competitors.

Chicago, Burlington & Quincy.—

Abandonment.—This company has applied to the Interstate Commerce Commission for authority to abandon its line between Sedan and Elmer, Mo., 4.43 miles.

CHICAGO, ROCK ISLAND & PACIFIC.—*Acquisition.*—The Interstate Commerce Commission has authorized this company to acquire 12.34 miles of line in Freeborn County, Minn., now operated under lease from the Minneapolis & St. Louis.

ERIE.—*Attack by C. & O. Stockholders' Protective Committee.*—The Chesapeake & Ohio Stockholders' Protective Committee has issued a circular entitled, "A Revelation," in which the physical condition of the Erie is attacked and C. & O. stockholders urged to co-operate to prevent the granting of the application of the C. & O. for permission to acquire control of the Erie and the Pere Marquette and to issue $59,502,400 additional common stock. "Some startling facts have been developed," reads the circular, "in the hearing now being conducted before the Interstate Commerce Commission on the application of the Chesapeake & Ohio to buy control of Erie and Pere Marquette—known as I. C. C. Finance Docket No. 6114. Inventory of equipment of Erie and its subsidiaries shows that a large part of the rolling stock is obsolete." Then follows a list of various equipment items showing ages. Other excerpts from the circular, indicative of its general tenor, follow:

"For the 11 years ended December 31, 1926, Erie, including Chicago & Erie, New York, Susquehanna & Western, the Wilkes-Barre & Eastern, the New Jersey & New York, and Bath & Hammondsport Railroads, used 1,111,638 cubic yards of ballast on their lines for maintenance, the total mileage of these lines at the close of 1926 being approximately 2,687 miles.

"Chesapeake & Ohio during the same period used 9,372,689 cubic yards of ballast on less mileage, its average mileage operated at the close of 1926 being 2,646 miles. For every cubic yard of ballast applied by Erie for maintenance during this 11-year period C. & O. applied 8.4 cubic yards. . . .

"For the six years ended December 31, 1926, Erie transferred from its income account to the credit of profit and loss account	$35,582,527
"During this six-year period, Erie received in dividends from its coal properties	40,500,000
"Thus showing a deficit in the six-year period from the operation of its rail lines of	$4,917,473

"From the standpoint of income, it would appear from these figures that Chesapeake & Ohio stockholders are buying anthracite coal mines instead of buying a railroad. . . ."

GREAT NORTHERN.—*Purchase of Line.*—This company has bought the Shevlin Hixon Company's railroad extending 25 miles southwest of Bend, Ore. This will be the first step in the extension of the Oregon Trunk from that city to Klamath Falls, Ore.

GULF, MOBILE & NORTHERN.—*Authorized to Operate into Jackson, Miss.*—The Interstate Commerce Commission has authorized this Company and the Jackson & Eastern to operate over the line of the New Orleans Great Northern for a distance of 5.7 miles through Jackson, Miss. It is also proposed to use the passenger terminals of the N. O. G. N. at Jackson.

MINERAL RANGE.—*Abandonment.*—This company has applied to the Interstate Commerce Commission for authority to abandon its branch line from St. Mary's Junction to Point Mills, Mich., a distance of 9.19 miles.

LAKE SUPERIOR & ISHPEMING.—*Stock Dividend.*—This company has applied to the Interstate Commerce Commission for authority to capitalize and distribute to its stockholders in the form of a 200 per cent stock dividend, $2,856,000 of the surplus earnings accumulated by the applicant and its predecessor companies during a period of more than thirty years which, the application says, "have been plowed back into the common carrier property of the company." The present capital stock of the company is $1,428,000 and the application says that after capitalization of $2,856,000 of surplus a surplus of $631,360 as of December 31, 1926, will be left. "The present capitalization of applicant is abnormally low," it says, "considering the character and value of its property and its annual earnings, and results in the payment of a comparatively high rate of dividend which gives an exaggerated impression of applicant's ratio of earnings. . . . The grand total valuation which this commission has placed upon the property now owned and possessed by this applicant (including non-carrier property valued by this commission at less than $10,000) is $9,033,495. This property is carried upon the books of applicant at the lower valuation of $7,865,938 so that if applicant were to adopt, for the purpose of computing its surplus, the valuation placed upon its common carrier property by this commission, it would result in an addition of $1,167,556 to the surplus of $3,467,360 shown on its books."

NORTHERN OF NEW JERSEY.—*Bonds.*—This company has applied to the Interstate Commerce Commission for authority to issue $707,000 of general mortgage 4½ per cent bonds, to be sold at 92½, the proceeds to be used to pay maturing obligations. The Erie, which has also asked authority to guarantee the bonds, proposes to enter into an agreement with Drexel & Co., to purchase or procure purchasers for the bonds at commission of 2 per cent.

ROCK ISLAND-FRISCO TERMINAL.—*Sale of Bonds.*—Speyer & Co., J. & W. Seligman & Co., and the Guaranty Company of New York have purchased, subject to the approval of the Interstate Commerce Commission, $3,390,000 Rock Island-Frisco Terminal Railway Company first mortgage thirty-year 4½ per cent Gold Bonds, due July 1, 1957, unconditionally guaranteed as to principal and interest, jointly and severally, by endorsement by the Chicago, Rock Island & Pacific and the St. Louis-San Francisco. The bonds are issued to refund a like amount of First Mortgage 5 per cent Bonds, which matured on January 1, 1927. The bonds have been placed privately at a price of 96½ and interest.

SOUTHERN PACIFIC.—*Bonds.*—This company has filed a supplemental application with the Interstate Commerce Commission for authority to sell, as well as issue, $20,000,000 of the issue of $61,294,000 of Oregon Lines first mortgage bonds recently authorized by the commission. It is proposed to sell the bonds to Kuhn, Loeb & Co. at 98 and interest.

UNION PACIFIC.—*Bonds.*—This company has applied to the Interstate Commerce Commission for authority to issue $26,835,000 of 40-year 4½ per cent bonds, for the purpose of refunding a like amount of 20-year 4 per cent convertible bonds which mature on July 1. The bonds have been sold, subject to the approval of the commission, to Kuhn, Loeb & Company, at 94¾.

WESTERN PACIFIC.—*Call of Bonds.*—This company has called for redemption at 102½ and interest on September 1, 1927, all of its $2,950,000, series B, 6 per cent first mortgage bonds. On that date the bonds will become payable at the principal office of the Equitable Trust Company, 37 Wall street, New York. In connection with its plans for retiring these bonds the company offers holders the option of exchanging their bonds for 5 per cent bonds issued under the same mortgage at not less than 99½. Any holder of the bonds called who desires to make such exchange must deposit its 6 per cent bonds with all unmatured coupons attached not later than August 1, 1927, with the Equitable Trust Company or the Crocker First Federal Trust Company of San Francisco.

Average Price of Stocks and Bonds

	June 7	Last week	Last year
Average price of 20 representative railway stocks..	114.96	115.20	93.17
Average price of 20 representative railway bonds..	94.23	94.46	91.47

Valuation Reports

The Interstate Commerce Commission has issued final or tentative valuation reports finding the final value for rate-making purposes of the property owned and used for common-carrier purposes as of the respective valuation dates as follows:

Final Reports

Chicago Short Line..........	$468,000	1919

Tentative Reports

Florida Central & Gulf.......	$428,080	1918
Gary & Western...............	1,325,000	1917
Indian Creek Valley.........	375,720	1918
Raleigh & Charleston.........	581,500	1918
Illinois Northern	961,023	1918

Dividends Declared

Atchison, Topeka & Santa Fe.—Preferred, $2.50, semi-annually, payable August 1 to holders of record June 24.

Chicago, North Shore & Milwaukee.—Preferred, 1½ per cent, quarterly; prior lien, 1¾ per cent, quarterly, both payable July 1 to holders of record June 15.

Cincinnati, New Orleans & Texas Pacific.—Common, 4 per cent, semi-annually, payable June 25 to holders of record June 11.

Lehigh Valley.—Common, $0.87½, quarterly, preferred, $1.25, quarterly, both payable July 1 to holders of record June 11.

Northern Securities.—4 per cent, payable July 11 to holders of record June 25.

Pere Marquette.—Common, 1½ per cent, quarterly, payable July 1 to holders of record June 14. Prior preference, 1¼ per cent, quarterly; five per cent preferred, 1¼ per cent, quarterly, both payable August 1 to holders of record July 14.

Pittsburgh, Fort Wayne & Ohio.—Common, 1¾ per cent, quarterly, payable July 1 to holders of record June 10. Preferred, 1¾ per cent, quarterly, payable July 5 to holders of record June 10.

St. Louis-San Francisco.—Common, 1¾ per cent, quarterly; common, $0.25, extra, both payable July 1 to holders of record June 8.

Railway Officers

Executive

M. F. Rolfe has been appointed assistant to the vice-president and general manager of the Maine Central, with headquarters at Portland, Me.

L. H. Cecil, assistant to the vice-president and general manager of the Texas and Louisiana lines of the Southern Pacific, with headquarters at Houston, Tex., has been apointed assistant to the executive vice-president, with headquarters at the same point. **T. H. Meeks,** assistant superintendent of the Beaumont division, with headquarters at Houston, has been promoted to succeed Mr. Cecil. **Tom Scott,** assistant superintendent of the Jacksonvile district of the Beaumont division, with headquarters at Jacksonville, Tex., has been appointed senior assistant superintendent of that division, succeeding Mr. Meeks.

Ira A. Place, vice-president, law, of the New York Central Lines, with headquarters at New York, has been appointed senior law vice-president of the New York Central Railroad, the Michigan Central, the Cleveland, Cincinnati, Chicago & St. Louis and the Pittsburgh & Lake Erie with the same headquarters. Mr. Place was born on May 8, 1854, at New York City, and was graduated from Cornell University in 1881. He entered railway service in October, 1883, with the New York, West Shore & Buffalo (now a part of the New York Central). From March, 1886, until October 28, 1902, he served

I. A. Place

in the law department of the New York Central & Hudson River (now a part of the New York Central). On the latter date he became general attorney for the same road, which position he held until April 5, 1905, when he was appointed general counsel. On December 5, 1906, Mr. Place became vice-president in charge of law, the land and tax department and the claim department of the same road. From December, 1919, until March, 1920, during Federal control, he served as general solicitor, and at the latter time became vice-president of the New York Central Lines.

Charles C. Paulding, assistant vice-president, law, of the New York Central Lines, with headquarters at New York City, has been appointed vice-president, public relations, of the New York Central Railroad, the Michigan Central, the Cleveland, Cincinnati, Chicago & St. Louis and the Pittsburgh & Lake Erie, with the same headquarters. Mr. Paulding was born on December 10, 1868 at New York City, and was graduated from Yale University in 1889. He en-

C. C. Paulding

tered railway service in 1889, in the law department of the New York Central & Hudson River (now a part of the New York Central), filling various positions in that department until April 1, 1920, when he became assistant vice-president, law, which position he was holding at the time of his recent appointment as vice-president, public relations.

Robert J. Cary, general counsel of the New York Central Lines, with headquarters at New York, has been appointed vice-president and general counsel of the New York Central Railroad, the Michigan Central, the Cleveland, Cincinnati, Chicago & St. Louis and the Pittsburgh & Lake Erie, with the same headquarters. Mr. Cary was born on February 6, 1868, at Milwaukee, Wis., and was graduated from Harvard University in 1890. He entered railway service in 1898 as a member of the firm of Cary & Walker, attorneys for the Indiana, Illinois & Iowa (now a part of the New York Central). This firm acted as general solicitors for that road until 1903, after which the firm of Glennon, Cary, Walker & Howe continued as general solicitors. He continued in the general practice of law in Chicago as a member of that firm (which subsequently was changed to Glennon, Cary, Walker & Murray)

R. J. Cary

until March 1, 1920, when he became general counsel for the New York Central, with headquarters at New York.

Financial, Legal and Accounting

S. L. Porter, auditor of freight accounts of the Chicago, Burlington & Quincy, has been promoted to auditor on the staff of the comptroller, with headquarters at Chicago, and has been succeeded by **H. C. Holzbach,** chief clerk to the auditor of freight accounts. **R. C. Smith,** chief clerk to the general auditor and comptroller, has been promoted to assistant auditor of freight accounts, with headquarters at Chicago.

William Henry Simpson, chief clerk to the auditor of the Ft. Smith & Western, has been promoted to auditor, with headquarters at Ft. Smith, Ark., succeding **H. B. Herendeen,** deceased. Mr. Simpson was born on September 14, 1884, at Jacksonville, Ill., and was educated in the public schools and in a business college in that city. He entered railway service at the age of 14 on the Jacksonville & St. Louis (now a part of the Chicago, Burlington & Quincy), serving on this railroad and the Wabash until 1907 when he entered the employ of the Indiana Harbor Belt at Hammond, Ind. In 1908 Mr. Simpson began his service with the Ft. Smith & Western as a clerk, becoming chief clerk to the auditor on August 15, 1918, which position he held until his promotion to auditor on May 23.

Operating

Robert H. Corson, assistant superintendent of telegraph of the Erie, with headquarters at Paterson, N. J., has been appointed superintendent of telegraph, with, the same headquarters succeeding **Edward P. Griffith,** deceased

E. J. Thomas, agent for the Detroit & Toledo Shore Line at Toledo, Ohio,

has been promoted to trainmaster, with headquarters at the same point, succeeding **V. A. Cooper**, retired under the pension rules of the company after more than 51 years of railway service.

N. P. Berney, assistant chief clerk to the assistant general manager of the Pacific lines of the Southern Pacific at Sacramento, Cal., has been promoted to supervisor of transportation of the Northern district, with headquarters at the same point, succeeding **T. R. Baird**, appointed assistant supervisor of transportation, with headquarters at San Francisco, Cal.

C. F. Franklin, passenger train supervisor on the Chicago, Rock Island & Pacific at Kansas City, Mo., has been promoted to passenger trainmaster on the Chicago Terminal division, with headquarters at Chicago, succeeding **C. G. Adams**, transferred to Goodland, Kan. **H. W. Hammack**, chief dispatcher at El Reno, Okla., has been promoted to trainmaster, with headquarters at the same point.

T. J. Foley, trainmaster on the Coast division of the Pacific lines of the Southern Pacific, with headquarters at San Francisco, Cal., has been promoted to assistant superintendent of the Shasta division, with headquarters at Dunsmuir, Cal., succeeding **J. D. Brennan**, transferred to the Western division, with headquarters at West Oakland, Cal. **A. A. Lowe** has been appointed trainmaster, succeeding Mr. Foley.

C. W. Brown, who has been appointed general superintendent of the Lehigh & New England, with headquarters at Bethlehem, Pa, was born on January 10, 1880, at Fort Gaines, Ga., and entered railway service on September 1, 1898, in the engineering department of the Central of Georgia. From 1900 to 1903 he was a transitman on the Baltimore & Ohio, and from the latter date until 1904, served as resident engineer for the same road. From August, 1904, until August, 1906, he was assistant engineer of the Atlantic Coast Line, and then became engineer of roadway for the same road, which position he held until May, 1908. From 1908 until 1909, Mr. Brown served as locating engineer on the Central of Georgia, and in 1910 became superintendent of the Hall Parker Construction Company, which position he held until 1911. From August, 1911, until December, 1913, he was engineer, maintenance of way of the Lehigh & New England, and at the latter time became assistant superintendent of the same road, which position he held until March, 1917. At that time Mr. Brown was advanced to superintendent of the same road, which position he was holding at the time of his recent appointment as general superintendent.

Earle E. McCarty, who has been appointed superintendent of the Albuquerque, division of the Atchison, Topeka & Santa Fe, with headquarters at Winslow, Ariz,, was born at Winona, Minn., and after receiving a high school education entered railway service in 1899 as a telegrapher on the Los Angeles division of the Santa Fe. Later he was advanced to agent on the same division and in 1902 he was promoted to train dispatcher at San Bernardino, Cal., where he remained until 1907 when he was again promoted to chief dispatcher at Needles, Cal. Mr. McCarty was then transferred to Fresno, Cal., being promoted to general inspector of transportation, with headquarters at Los Angeles, Cal., in 1909. Three years later he became trainmaster at Winslow, serving in the same capacity successively at Needles and San Bernardino. At the outbreak of the World War Mr. McCarty was appointed to the troop movement section of the American Railway Association and the United States Railroad Administration, with headquarters at Camp Kearney, Cal., and at the close of hostilities he returned to the Santa Fe as trainmaster at Needles. He was transferred to San Bernardino following his appointment at Needles and in 1923 he was promoted to assistant superintendent, with headquarters at the same point. From 1924 to 1926 Mr. McCarty served as trainmaster at San Bernardino and prior to his promotion to superintendent of the Albuquerque division on May 20 he was acting superintendent of the same division from November 20, 1926.

R. K. Rochester, general superintendent of the New Jersey division of the Pennsylvania, with headquarters at New York City, has been appointed assistant general manager of the Eastern region, with the same headquarters. **R. C. Morse**, general superintendent of the Northern division at Buffalo, N. Y., has succeeded Mr. Rochester as general superintendent of the New Jersey division. **F. D. Davis**, general superintendent of transportation of the Western region, with headquarters at Chicago, Ill., has been appointed general superintendent of the Northern division. **W. C. Higginbottom**, superintendent of the Philadelphia division, with headquarters at Harrisburg, Pa., has been appointed general superintendent of transportation of the Western region at Chicago. **J. B. Phelan**, superintendent of freight transportation of the Eastern region at Philadelphia, has been appointed superintendent of the Philadelphia division at Harrisburg. **P. W. Sullivan**, superintendent of the Columbus division, with headquarters at Columbus, O., has become superintendent of the Eastern division, with headquarters at Pittsburgh, Pa., succeeding **Porter Allen**, who was promoted to the position of chief engineer maintenance of way of the Western region on June 1. **J. A. Appleton**, superintendent of the Erie and Ashtabula division at Newcastle, Pa., has succeeded Mr. Sullivan as superintendent of the Columbus division. **Raymond Swenk**, engineer maintenance of way of the Southern division at Wilmington, Del., has been appointed superintendent of the Erie and Ashtabula division at Newcastle, Pa. **N. S. Menaugh**, freight trainmaster of the Pittsburgh division, has been appointed superintendent of freight transportation of the Eastern region at Philadelphia. All appointments are effective June 16.

Traffic

F. M. Keane has been appointed assistant coal freight agent of the Baltimore & Ohio, with headquarters at Pittsburgh, Pa.

H. A. Triebel, chief of the tariff bureau of the Chicago, Rock Island & Pacific, with headquarters at Chicago, has been appointed assistant general freight agent, with headquarters at the same point.

G. C. Robson has been appointed district passenger agent of the Southern, with headquarters at Dallas, Tex., and **C. D. Whitworth** has been appointed district passenger agent at New Orleans, La.

Wins F. Wilson, assistant general freight agent of the Southern, lines East, with headquarters at Richmond, Va., has been appointed general freight agent, lines East, with the same headquarters, succeeding **J. H. Drake**, deceased. **J. H. McCabe** has been appointed assistant general freight agent at Richmond, Va., succeeding Mr. Wilson.

J. V. Lanigan, who has been promoted to passenger traffic manager of the Illinois Central, was born at St. Louis, Mo., and entered railway service as a clerk in the passenger department of the Chicago, Burlington & Quincy. After occupying a number of clerical positions on the Burlington he became a rate clerk in the passenger depart-

J. V. Lanigan

ment of the Missouri, Kansas & Texas in 1904. Two years later he began his connection with the Illinois Central as a rate clerk in the passenger department and in January, 1908, he was promoted to chief rate clerk in the same department. On April 15, 1911, Mr. Lanigan was advanced to assistant general passenger agent at Chicago, be-

coming general passenger agent, with headquarters at the same point, in December, 1921. Mr. Lanigan was serving in this capacity when he was promoted to passenger traffic manager, with headquarters at Chicago, on June 1.

L. W. Land has been appointed division freight agent of the Baltimore & Ohio, with headquarters at St. Louis, Mo., in charge of St. Louis, Mo., East St. Louis, Ill., district and St. Louis division west of Flora, Ill., including off-line territory in the state of Illinois on and west of Illinois Terminal Railroad, Alton to Formosa, also south and west of the Baltimore & Ohio, Caseyville, through Flora to Shawneetown.

E. E. Nelson, who has been promoted to assistant passenger traffic manager of the Northern Pacific, with headquarters at St. Paul, Minn., received his early education at St. Paul. He began his railroad service as a stenographer in the general traffic offices of the Northern Pacific in 1901, and was ad-

E. E. Nelson

vanced successively through a number of minor positions in the traffic department until 1912 when he was promoted to assistant general passenger agent, with headquarters at St. Paul. In 1923 Mr. Nelson was transferred to Seattle, Wash., remaining there as assistant general passenger agent until his promotion to assistant passenger traffic manager on June 1.

G. G. Truesdale, who has been promoted to general passenger agent of the Illinois Central, with headquarters at Chicago, was born in Richmond, Ill., graduating from Hyde Park High school, Chicago, in 1901. In July of the same year he entered the service of the Illinois Central as an office boy in the transportation department at Chicago. Mr. Truesdale was transferred to the passenger department in October, 1902, serving here until May, 1906, as a clerk and stenographer. He was then promoted to traveling passenger agent, with headquarters at Cincinnati, Ohio, becoming city passenger and ticket agent at the same point on January 1, 1908, where he remained until January 1, 1911, when he was appointed city passenger agent at Chicago. From October, 1911, to July, 1917, Mr. Truesdale acted as district passenger agent at Pittsburgh, Pa., and on the latter date he was appointed commercial agent in the freight department at New York. At the beginning of federal

G. G. Truesdale

control of the railroads he left railroad service to enter other traffic work, returning to the Illinois Central as assistant general passenger agent on December 5, 1921. Mr. Truesdale occupied this position until his promotion to general passenger agent on June 1.

Gordon L. Oliver, who has been appointed traffic manager of the Ft. Worth & Rio Grande, the St. Louis, San Francisco & Texas and the Paris & Great Northern, subsidiaries of the St. Louis-San Francisco, was born on May 4, 1886, at Hawick, Roxburghshire, Scotland. He attended St. Mary's Preparatory Scohol, Melrose, Scotland, and Loretto College, Edinburgh, and came to the United States in March, 1905. The following month he entered the service

G. L. Oliver

of the Chicago, Rock Island & Pacific as an office boy in the traffic department at Chicago. In 1911 he became traffic manager of the Star Wall Paper Mills, Joilet, Ill., returning to railway service in 1912 in the traffic department of the Frisco at St. Louis, Mo. In 1913 Mr. Oliver was appointed chief clerk to the general freight and passenger agent of the Ft. Smith & Western, with headquarters at Ft. Smith, Ark. Two years later he was advanced to assistant general freight and passenger agent, becoming general freight and passenger agent in 1917 and traffic manager on September 1, 1921. Mr. Oliver was appointed traffic manager of the Muscle Shoals, Birmingham & Pensacola on April 15, 1926, after its acquisition by the Frisco, with headquarters at Pensacola, Fla., a position he held until his appointment as traffic manager of the Texas lines of the Frisco on June 1.

F. W. D. Goddard, assistant general freight and passenger agent of the Lehigh & New England, with headquarters at Bethlehem, Pa., has been appointed general freight and passenger agent, with the same headquarters. The position of assistant general freight and passenger agent has been abolished.

Mechanical

G. S. Goodwin, mechanical engineer of the Chicago, Rock Island & Pacific, with headquarters at Chicago, has been appointed assistant to the general superintendent of motive power, with headquarters at the same point.

J. L. Bracken, engineering assistant on the New York, New Haven & Hartford, with headquarters at New Haven, Conn., has been appointed assistant to the mechanical superintendent of the New York division, with headquarters at New York City.

Engineering, Maintenance of Way and Signaling

V. L. Nelson has been appointed acting valuation engineer of the New York Central, Ohio Central Lines, succeeding **H. F. Schryver,** engaged upon duties in another department.

H. O. Kaigler has been appointed division engineer of the West Florida division of the Seaboard Air Line, with headquarters at Tampa, Fla., succeeding **G. W. Shoemaker,** who has been transferred to the Virginia division as assistant division engineer, with headquarters at Raleigh, N. C., succeeding Mr. Kaigler.

J. H. Cooper, division engineer of the Philadelphia Terminal division of the Pennsylvania at West Philadelphia, Pa., has been appointed engineer maintenance of way of the Southern division, with headquarters at Wilmington, Del., succeeding **Raymond Swenk,** promoted. **F. M. Hawthorne,** division engineer of the Cleveland and Pittsburgh division at Cleveland, O., has succeeded Mr. Cooper as division engineer of the Philadelphia Terminal division. **H. T. Frushour,** assistant division engineer of the Cincinnati division at Cincinnati, O., has been appointed division engineer of the Cleveland and

Pittsburgh division at Cleveland, succeeding Mr. Hawthorne. All appointments are effective June 16.

H. F. Schryver, valuation engineer of the Ohio Central lines of the New York Central, with headquarters at Columbus, O., has been transferred to the chief engineer's office as principal assistant engineer, with the same headquarters. **C. V. Bucher**, principal assistant engineer at Columbus, has been transferred to Charleston, W. Va., as division engineer. **G. H. Smith**, division engineer at Bucyrus, O., has been transferred in the same capacity to Columbus, O. **J. Boler**, supervisor of bridges and buildings at Bucyrus, O., has been transferred in the same capacity to Columbus, O. **H. H. Baldwin** has been appointed supervisor at Hobson, O. **R. C. Billet**, supervisor at Bucyrus, has been transferred to Fostoria, O. **C. A. Geiger**, assistant division engineer at Bucyrus, has been appointed supervisor at Toledo, O., and **J. E. Temple**, supervisor at Fultonham, O., has been transferred to Corning, O. **C. M. McVay**, division engineer at Charleston, W. Va., has been temporarily assigned to special construction work.

Eric Gustaf Ericson, assistant to the chief engineer of the Pennsylvania, attached to the Central region, with headquarters at Pittsburgh Pa., retired under the pension rules of the company on May 31, after completing nearly 44 continuous years of service with the same railroad. Mr. Ericson was born at Ramdala, Sweden, on May 7, 1857, and graduated from the Royal Polytechnical Institute at Stockholm with the degree of civil engineer in June, 1880. For the two years following he

E. G. Ericson

was engaged in surveys for canal projects and in charge of harbor improvements in Sweden. Later he spent a year as resident engineer in charge of the location and construction of a railroad on the west coast of Sweden. Mr. Ericson came to the United States in August, 1883, shortly thereafter entering the service of the Pennsylvania as a draftsman and serving later as a transitman in the office of the chief engineer. On April 1, 1886, he was advanced to supervisor on the Pittsburgh, Ft. Wayne & Chicago (now a part of the Pennsylvania) at Wooster, Ohio, and on July 1, 1890, he was promoted to engineer of maintenance of way of the Cincinnati & Muskingum Valley (now a part of the Pennsylvania), with headquarters at Zanesville, Ohio. After July 1, 1893, when he was promoted to engineer of maintenance of way of the Western division of the P., Ft. W. & C., Mr. Ericson served successively as assistant engineer in charge of construction and maintenance on the Pennsylvania Lines West and as principal assistant engineer of the Northwest region. He remained as principal assistant engineer of the Northwest region until 1917 when, during federal control, he was promoted to principal assistant engineer of construction of the line west of Pittsburgh. In 1920, Mr. Ericson was appointed assistant to the chief engineer of the system, which position he held until his retirement.

Purchases and Stores

Eugene Decker, chief clerk to the purchasing agent of the Maine Central, has been appointed purchasing agent, with headquarters at Portland, Me., succeeding **C. D. Barrows**, deceased.

Special

A. Quirk, chief clerk to the superintendent of the Missouri-Kansas-Texas at Parsons, Kan., has been appointed athletic director, with headquarters at the same point, a newly created position.

Obituary

Charles D. Barrows, purchasing agent of the Maine Central, with headquarters at Portland, Me., died on May 12 after an illness of several weeks. Mr. Barrows was born on November 12, 1871, at Lowell, Mass. He later moved to San Francisco, Cal., where he received his early education. In 1889 he came east and entered Dartmouth College from which college he was graduated in 1894. On Noverber 12 of the same year he entered the service of the Maine Central as a clerk in the offices of the general passenger agent. On November 16, 1895, he was transferred to the supply department, and was appointed purchasing agent on August 1, 1898, which position he was holding at the time of his death.

William Henry Brill, general passenger agent of the Illinois Central at New Orleans, La., who died on May 20, was born on October 19, 1869, at Weston, Mo. He entered railway service in 1888 with the St. Joseph Union Depot Company, St. Joseph, Mo., becoming a traveling passenger agent on the Illinois Central at St. Louis, Mo., in 1894. In 1900 Mr. Brill was promoted to district passenger agent, with headquarters at Omaha, Neb. Later he was transferred to Chicago and to St. Louis, and in 1911 he was promoted to assistant general passenger agent at New Orleans. Mr. Brill was advanced to general passenger agent, with headquarters at the same point, in 1920, which position he held until his death.

Charles H. Ackert, who retired as vice-president of the Chicago & Alton in 1910, died on June 5 at his home at Lake Forest, Ill. Since his retirement from railway service Mr. Ackert has been president of the National Railway Time Service Company, Chicago. Mr. Ackert was born on February 19, 1856, in Dutchess County, N. Y., and entered railway service in 1872 as a telegraph operator. He held various positions in the operating departments of western railroads until 1888 when he became general manager of the Iowa Central (now a part of the Minneapolis & St. Louis). On April 1, 1893, he was appointed general manager of the Elgin, Joliet & Eastern and on the same date in 1899 he became president as well as general manager of this company and the Chicago, Lake Shore & Eastern (now a part of the E. J. & E.). Two years later Mr. Ackert became general manager of the Mobile & Ohio, where he remained until March 15, 1902, when he was appointed general manager of the Southern. On April 1, 1905, he was elected fourth vice-president of the Southern, resigning to become vice-president of the Chicago & Alton in 1909.

Richard C. Campbell, general freight agent of the Reading, with headquarters at Philadelphia, Pa., died on June 7 after a protracted illness at his home in Wyncote, Pa. Mr. Campbell was born at Davenport, Ia., on September 2, 1866, and attended the public and private schools at Davenport, Ia, the Greylock Institute, South Williamstown, Mass., and Williams College. He entered the service of the Reading in November, 1890, as student at the office of the shipping and freight agent at Port Richmond, Philadelphia. Later he became assistant inspector of the Philadelphia & Reading Coal & Iron Company. In January, 1891, he became traveling coal inspector, line sales agent's office of the same company at Philadelphia, and in January, 1894, became chief clerk. In November, 1896, Mr. Campbell became chief clerk to the general manager and later became chief clerk to the second vice-president of the Philadelphia & Reading (now the Reading). In August, 1899, he was appointed general western freight agent at Chicago and in February, 1910, acted for the Central of New Jersey in the same capacity. In May, 1918, he was advanced to special agent in the freight traffic department, and in March, 1919, became general western freight agent at Chicago. In September, 1922, he was appointed assistant general freight agent at Philadelphia, and in April, 1923, was again advanced to general freight agent, with the same headquarters, which position he was holding at the time of his death.